THE FOUNDRY

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Problems of the Foundry Discussed at Chicago

Proceedings of the Annual Meetings of the American Foundrymen's Association and the Associated Foundry Foremen, With Entertainment Features

A FITTING tribute to the great work that is being done in behalf of the foundry industry of the world, was the large attendance at the annual convention of the American Foundrymen's Association, held at the LaSalle hotel, Chicago, Oct. 14-17. Interesting and instructive discussion followed the reading of nearly every paper presented, and the proceedings were of the utmost helpfulness to those in attendance. The spirit of the meeting clearly indicated a great desire on the part of foundrymen everywhere to profit through the interchange of information and a willingness to co-operate to the utmost for the general good of all. The papers and discussions also delineated the most important technical problems confronting the manufacturers of castings at the present time and prompted definite steps toward their solution.

Among these problems are those of cost keeping systems of all classes of foundries and standard practice in steel casting shops. These two questions will be the object of searching study during the coming year by special committees representing the American Foundrymen's Association. The personnel of the committees will be carefully chosen in order that they may command the utmost skill and experience. The committee work of the society is growing in volume and importance year by year and it is the policy of the organization to further strengthen its efforts along this line.

Excellent facilities for conducting the professional sessions were afforded in the magnificent ball room of the LaSalle hotel and the large registration from all sections of the country reflected the constantly growing interest in problems relating to foundry practice. The Chicago committee provided an interesting series of entertainments for the members and their guests and in many ways added to the enjoyment of the occasion.

At the joint session on Tuesday morning, the visiting foundrymen were greeted with appropriate words of welcome by Chas. A. Plamondon, chairman of the Chicago committee; Wm. H. Sexton, corporation counsel for the city of Chicago; E. C. Ferguson, of the Association of Commerce, and O. J. Abell, for the entertainment committee. Alfred E. Howell, senior vice president of the American Foundrymen's Association, replied to the address of welcome. In a pleasing and humorous manner he touched on the early history of Illinois and the great commercial growth of Chicago, characterizing the latter as one of the seven wonders of the world. In his annual address, H. D. Miles, president of the American Foundrymen's Association, discussed many important subject. He pointed out the advantages of holding the annual conventions each year in a different city, thus giving the foundrymen an opportunity to observe and compare shop operations in different parts of the country. Mr. Miles' address follows in part:

ALFRED E. HOWELL,
President American Foundrymen's Association

We convene today in the second largest city on this continent, located in a district wherein are established many plants for the manufacture of iron and steel and the machinery in which such products are used. The foundry industry here is very large and some plants represent the most modern development in the foundry art. Our practice of holding our conventions in cities in different parts of the United States and Canada stimulates interest, increases our activities and accomplishes the most far reaching results. It is in proportion to the interest we create that our membership increases and that funds are supplied for carrying on the work, and it is important, therefore, that we continue the practice of changing our

meeting place yearly. Supplementing this, however, should be frequent campaigns for new members. The officers of the American Foundrymen's Association carried on such a campaign this year with very satisfactory results. Our membership has been increased more than 20 per cent over last year. We now have the largest membership since our organization and our income for the year is nearly 20 per cent greater than for our best previous year.

Lack of Interest Shown

One of the difficulties we experienced is a lack of proper interest by some of our members in the work we do and the help we offer. The managers of plants are frequently too busy with general matters to give the time to study the lessons we teach, and I would suggest as a remedy that each of said managers designate some one person among his employes best qualified for the work to attend to association matters, read the articles we publish, attend conventions, and from the knowledge obtained report on betterments which it would be advantageous to adopt. While our work is educational, its purpose is commercial and the result should be expressed in increased earnings. Those members who serve as teachers, do so gratuitously and their unselfish work merits our thanks and our careful attention and study. It is a free school, where much can be learned, and we are not alert if we do not take advantage of the opportunities offered.

I would be glad to see more general interest taken in the discussion of papers read. Each of you should have some knowledge garnered through experience on some of the topics under discussion and should be willing to impart it, even though you do not like to talk in meetings. We are here to help ourselves by helping others.

Committee Work

I would be glad to see more work done by committees, problems studied and remedies determined. We should have a committee on standard foundry costs, which will have authority to employ a high grade expert to assist it, and after a proper system is prepared and adopted by the association, every effort should be made for its general installation in foundries. Costs must be known before reduction in them can be intelligently made. Costs must be known before intelligent bidding can be done and costs must be known if the percentage of failures are to be reduced. A proper cost system intelligently used is necessary to the efficient operation of a plant and to the correct determination of prices on products for sale, and the same general system should be used by all concerns in any one line of manufacture. In any competitive field, it is the ignorant bidder who causes the trouble which leads to bankruptcy or monopolistic combinations formed for self-preservation. I believe that most monopolies were formed not for the purpose of making excessive and unlawful profits, but in order to secure any profit at all. It was only after they felt the strength and security of their positions that combinations began to misuse their power. The day may come when governmental commissions will regulate all industries, determine costs and selling prices, and the number and locations of plants. When that time arrives, there will be uniformity, if not efficiency, but until it does arrive, we must make the best use we can of such associations as this to establish reliable and standard cost systems and up-to-date and efficient methods of operation.

S. V. BLAIR,
President Associated Foundry Foremen

This association some years ago formulated a system of costs, and distributed the information among its membership. That time has so long passed and so many members have been taken in since that time, that it is important that the subject again be taken in hand and the most modern method worked out and made use of. Other notable problems have been solved by this association, but there is much yet to do, and we should have the will to do it and I solicit the aid of all members in the work.

The new tariff laws are in effect, and what the ultimate results will be, it is impossible to accurately forecast. That so radical reduction in duties will greatly alter conditions in some lines of trade can be safely predicted. The fact that our labor per day, per man, costs from two to three times what such labor costs in Europe, means that our labor must be two or three times as efficient working in conjunction with our modern shop equipment as European labor is working with foreign plant equipment. This condition causes great anxiety among managers and owners of industries on this side of the ocean. Either our efficiency is the marvel of the age, or else our labor must be content with a lesser wage if the present duties on some products are to be maintained. Our American optimism hopes for the best and will do its utmost to resist the worst, and this association must do its share to suggest ways and means of increasing output and at the same time reducing costs.

I cannot close my remarks without expressing my sincere appreciation of the splendid work done by my good friend, Dr. Richard Moldenke. His technical education, his high sense of duty, his untiring energy and his wide and valuable acquaintance make him an ideal secretary for our association. It was only by my close official connection with him that I am able to appreciate the great amount of and the valuable work he has done and is doing.

R. S. BUCH, H. R. ATWATER AND J. S. McCORMICK ARRIVING FOR AN OFFICIAL INSPECTION OF THE EXHIBITION

Secretary's Report

In his thirteenth annual report, Dr. Richard Moldenke, secretary of the American Foundrymen's Association, emphasized the suggestions of Mr. Miles in regard to the work of the committee on standard cost accounting. Dr. Moldenke stated that a new report from this committee, which would include the details of a new foundry cost system, would be ready in the course of a few weeks. Dr. Moldenke's report follows in part:

The last few years have been notable in the foundry world for the attention given to cupola practice. The work done by our association in this direction, and

the stimulus given to individual investigators here and abroad, has been such that today we may truly say that melting iron in the cupola is at last on a scientific basis. The idea that every cupola has its mysterious ailments and must be humored and prescribed for specially, is now exploded, and the foundryman knows that whether his cupola be big or little, whether run continuously or for a few hours at a time only, certain definite relations between volume of air supply, position of the fuel bed, and maintenance of melting at the zone of highest efficiency and temperature through small and properly distributed charges, are requisite in order to avoid all these troubles which castings are heir to, even when starting with the highest grade of metal.

Importance of Costs

Two other problems also stand out prominently. First, the unusual demand for accident statistics, particularly the investigation made by our association several years ago, the reports of which have been speedily exhausted. Second, the general feeling that standard cost accounts are highly desirable. The standard system for foundry costs prepared for our association by its committee of cost experts and efficiency engineers, is being revised and elaborated so that it will prove more useful to the individual members. This report was not quite completed in time for the convention, but will be distributed later. With the radical change in the tariff now in effect, and the general feeling of uncertainty prevailing, it is quite patent to the thoughtful observer—particularly if he knows anything of the economies practiced in those countries which are certain to benefit by the change in policy—that we must prepare to use the knife on our cost items where, heretofore, we have been rather easy going. This country does not realize how wasteful everything has been carried on, and it needed the jar of radical action to bring this home to us. It is to be hoped that we will not go efficiency-mad as a consequence, but rather that we study human nature, select men for their best work, use only quality factors in the make-up of our product, and see that the pound of iron goes further than ever before.

In the chase after commercial supremacy, the nations of the earth often sin grievously. We in America have our share to explain also. We have, however, a fairly good reputation for liberality in showing our establishments. This is not the case in so great a measure in other countries, and as we are consequently at some disadvantage in the race, occasion was had to enter a rather energetic protest during the year, when one of our valued members was excluded from establishments, whose representatives had been liberally treated here. A circular letter was addressed to all the interested societies of the country, much correspondence had, and an almost general agreement reached looking toward liberality in showing our establishments only when reciprocal courtesy is promised. Since that time no one is given an introduction from our office to the membership until his promise to reciprocate by opening his own establishment has been obtained.

GEORGE H. MARTIN,
Vice President, Associated Foundry Foremen

Dearth of Papers

A situation that requires attention is becoming rather manifest in the foundry world of late, if the good work of this association is to continue. Editors of the great trade journals have noted the same thing. It is no longer possible to obtain a wealth of papers and discussions. The foundry as a subject—limited in a manner anyhow—is becoming too well threshed out, and while our more recent papers are not as crude as many examples of former times, nevertheless there are no more startling advances to herald or subjects to dig into readily.

It therefore is absolutely necessary to follow the lead of our large engineering and industrial associations, in creating efficient and representative committees on securing papers. Not only has the change from the regular spring convention to the fall proved most disastrous in this direction, but the burden of gathering this material has become too heavy for your secretary and the few fellow-officers who aid him in this work. When nearly three-quarters of the letters inviting co-operation from men able to write papers are not even given the attention of a reply, it is no longer a pleasure to try to provide a program of wide range and good value. It is to be hoped, therefore, that willing hands will be found to help the good work along.

Increase of Membership

Thanks to the energetic work of our president, Mr. Miles, and also to our vice presidents, a large number of new members have been obtained, not only filling up the depletion in the ranks due to defections, but so augmenting them that today we have 729 members. We therefore have about 10 per cent of the total foundries of the country, instead of 90 per cent, as it should be. Only those who know how difficult it is to get men to help create instead of reaping without sowing, will realize that 10 per cent is a very fine showing.

MAJOR JOSEPH T. SPEER AND J. S. SEAMAN, TWO FORMER PRESIDENTS OF THE A. F. A., WHO NEVER MISS A MEETING

Industrial Education

The report of the A. F. A. committee on industrial education covered the progress of the year in this important line of endeavor. Some portions of this report follow:

There is an increasing sentiment among the authorities in charge of technical and industrial schools in favor of adding foundries to their school equipment. While, from the standpoint of the practical needs of the foundry industry, these school foundries are of little immediate help, nevertheless, the movement is gratifying and helpful as a recognition of the value of the industry. However, whatever the willingness of the school authorities may be, there is not prospect at present for the establishment of special preparatory schools for the

foundry. There is a growing disposition by municipalities to establish continuation schools, part-time schools, technical high schools or industrial departments in academic high schools, according to the needs of the locality. As a counterpart to this disposition toward

THOMAS E. COALE HAS A BUNCH OF CARLOAD LOT PATTERN LUMBER ORDERS

general preparatory industrial schools by municipalities, there is a growing tendency on the part of railway companies and manufacturers to establish shop schools, that is apprentice schools of their own. There are at present 71 such schools in successful operation.

There is a movement on foot now to create a system of vocational schools, separate and distinct from the existing organized system of public schools, leaving the public school to follow in the wake of the industrial school if it will, but making no particular attempt to benefit from the traditional educational system. The cause of this movement is the almost universal unsympathetic attitude of the school people toward industrial education, and the fear that as manual training has been emasculated and has been made a part of the academic school system to the disadvantage of industries, so likewise would industrial courses be soon emasculated and become part of the academic school system dominated over by the academic teacher.

While this condition exists, the foundries have an opportunity to do something themselves to relieve the situation. The problem is not so much to get boys with a specific trade training, because boys who have passed through schools where such training is given will not stay permanently as molders in foundries, but to get boys with some degree of developed general intelligence, or to develop that intelligence while they are at work. Conditions are more favorable now to do this with the co-operation of the schools, than they were last year or the year before. States, municipalities and the school people are more ready to help the industries than they were formerly.

Sanitary Shops

The first step is to put the foundries and work shops in as good sanitary and clean condition as is possible and insist upon them being kept so. Hygienic, charitable, child-labor and similar congresses are continually educating the people up to the necessity of healthy surroundings and at the same time proving, in one way or another, how the physical efficiency and therefore the productive capacity of the worker in shop, store and office is increased. Foundrymen should insist upon the beginning of a preparation in the seventh and eight grade for industrial life. The school people are much more willing to listen to such a proposition now than formerly and differentiation of courses in the seventh and eighth grades to meet the demands of industrial life have been frequently discussed lately in teachers' conventions. It is admitted that such a change would hold many who now drop out at 14 years with a sixth and seventh grade education only.

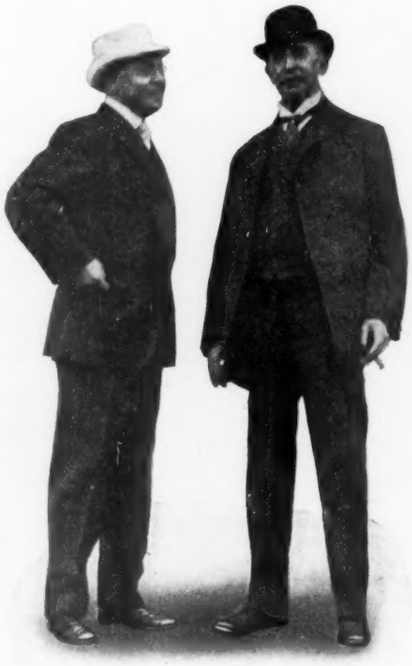
General Electric Apprenticeship System

At the joint session on Tuesday afternoon, M. W. Alexander, of the General Electric Co., Lynn, Mass., gave an interesting address, illustrated with lantern slides, on the "Apprenticeship System in the Metal Industries". He referred particularly to trade apprentices and pointed out the vital necessity for providing better systems for the development of skilled workmen. In some detail he outlined the methods employed by the General Electric Co. in this work. Mr. Alexander's address was an illuminating sidelight on the problems surrounding the proper training of shop apprentices as outlined in the report of the committee on industrial education quoted above.

C. E. Knoeppel, New York, in an address following Mr. Alexander, pointed out how to proceed to make a time study. In his opening paragraphs, Mr. Knoeppel cited instances to show where careful time studies, coupled with an application of efficiency principles, had effected great reduction in molding costs. In one case the cost of molding pommels for pack saddles was reduced from $1.17 to $0.54, while the earnings of the molder increased from $3.28 to $5.74 per day. In another case, the time required to make the mold for a large steel casting was reduced 32½ per cent; the cost of doing the work was cut 30 per cent; the production of the shop increased 60 per cent, and the earnings of the molders increased 12 per cent. He then took up the details of his subject, discussing the elements to be considered in making a time study, the variables of the men and the work, the tools needed, the classes of studies, the determination of fair standards, the separation of inefficiency, the making of more than one study at a time, correcting for errors and the practical uses of time study data.

A valuable discussion of the effect of silicon on the characteristics of gray iron castings and the relative merits of charcoal and coke pig iron was precipitated by a paper entitled "Gray Iron for Motor Car Castings", by H. B. Swan, of the Cadillac Motor Car Co., Detroit.

The discussion tended to the opinion that for intricate work, such as motor car cylinders, charcoal pig iron was preferable because good castings could be made with a minimum of silicon. It was pointed out also that the scrap available in this country contains more sulphur every year; not



E. J. WOODISON AND D. S. ROBESON DISCUSS CORE BINDERS

long ago, said Dr. Moldenke, the average amount of sulphur in foundry scrap was 0.06 per cent and now it is 0.12 per cent. The tendency of excessive amounts of silicon, over 2 per cent, to make gray iron castings

gritty and very difficult to machine was commented on by several speakers, but it was made plain that much more care and skill in managing the cupola are necessary to make good castings with low silicon than with strong, high silicon pig.

Pouring Steel Castings

R. A. Bull, superintendent of the Commonwealth Steel Co., Granite City, Ill., presented an exceedingly interesting paper entitled "Some Difficulties in Pouring Steel Castings", which is published elsewhere in this issue.

The difficulty of obtaining a supply of satisfactory nozzles and stoppers for bottom-pour steel ladles was tellingly portrayed by John Ploehn, of French & Hecht, Davenport, Ia. During the summer, Mr. Ploehn visited the principal manufacturers of refractory brick and found that there are six different nozzle designs in general use for ingot-pouring and many more for steel foundry work.

GEORGE R. RAYNER WAS WELL SATISFIED WITH THE EXHIBITION

The steel foundry nozzles vary from 1 to 2½ inches in diameter of bore, with about 14 different styles for each size. In many cases the variations are only slight. On account of this great range in sizes and designs, the refractory manufacturers are able to make nozzles only in small quantities, causing dissatisfaction both to the producer and consumer. As a result of Mr. Bull's paper and Mr. Ploehn's discussion, a motion was passed to appoint a committee on steel casting shop practice empowered to develop a standard design for ladle nozzles and stoppers and report at the 1914 convention. It is felt that this and other standardizations would be of great service to the steel foundrymen.

Albert Hiorth read a paper giving the details of his electric induction furnace and facts regarding its operation in the manufacture of steel. F. T. Snyder, of the Metallurgic Engineering Co., Chicago, discussed electric steel castings and read figures showing a cost of electric steel made under foundry conditions of from $18.30 to $26.14 per ton. This covers cost of melted metal in the ladle.

Gray Iron Foundry Problems

The problems of the gray iron foundry were discussed in a group of papers covering cast iron specifications, core testing, automobile cylinder work, molding sand tests and general suggestions regarding jobbing foundry operation.

The need for standard specifications for cast iron was pointed out in a paper by R. S. MacPherran, West Allis, Wis., which follows in part:

There are specifications calling for test bars 1¼ x 12 inches round; 1 x 2 x 24 inches; 1 x 1 x 12 inches; 1 x 1 x 4 feet, 6 inches; 1 x 1 x 4 feet, 8 inches, etc. Sometimes the bars are to be corrected to some definite sized bar, and sometimes to some unfamiliar quality factor. Some specifications call for transverse bars only, some for tensile only, and some for both.

The minimum breaking load for 1 x 2 x 24-inch transverse bars varies from 1,700 to 2,500 pounds, and the tensile strength per square inch from 18,500 to 25,000 pounds. One specification calls for a tensile strength of 18,500 pounds with an "allowable variation of 5 per cent either way". These different requirements on the part of engineers only serve to confuse the manufacturer. In the writer's opinion, much should be left to the judgment and experience of the latter.

In a shop where a certain kind of castings are a part of the regular output, the shop practice in making them is based on actual experience both in manufacture and in service. A purchaser calling for changes from this shop should do so only after careful consideration of the situation and for some definite reason. It is too often the case that a specification is copied from some handbook and inserted bodily in a contract without regard to the class of material it is to cover. In one case in the writer's experience the specification for suction piping called for a breaking load of 2,200 pounds on a transverse bar 1 x 2 inches x 24 inches between supports. The same specification called for a tensile strength of 20,000 pounds per square inch on bars cast to represent the steam cylinders. During the manufacture of this engine, a set of transverse bars broke below 2,200 pounds

R. A. BULL, ONE OF THE STEEL CASTING EXPERTS IN ATTENDANCE

and caused the rejection of a suction pipe. The tensile bars from the same iron broke above 20,000 pounds per square inch, which would have passed a high pressure steam cylinder. We have here the anomaly of a material satisfactory for steam cylinders, but causing the rejection of a suction pipe.

Tests For Cast Iron

In the discussion following this paper there was some controversy regarding the relative advantages of tensile and transverse tests for cast iron, but the consensus of opinion was strongly in favor of the tranverse bar on account of simplicity and economy. Transverse tests are easily made and the apparatus required is much less expensive than that necessary for tensile tests. Also the transverse test is more sensitive to the slight elasticity of cast iron.

The following summarizes a paper on "Automobile Cylinder Founding", by Robert Crawford, of the Atlas Foundry Co., Detroit:

The unfortunate situation in the

automobile industry is that the purchasing agent looks for cheap castings, and the foundryman simply has to use a lot of scrap of which he knows little or nothing. The result is a wailing in the machine shop which is not good to hear. Those who know will not be bluffed into this way of doing business. They will use the best of material and charge their price. Not only has the temptation to quote a low price and then make up by using cheap scrap caused much disaster, but the advent of the automobile engineers has given us 5/32 inch and 3/16 inch water jackets, where 7/32 inch and ¼ inch had been the rule. The great strain from vibration and the gas explosions on the cylinders, pistons and rings has proven conclusively that it is wise to start with a good foundation in the way of raw materials, and then to melt them right.

"With ordinary mixtures," said H. M. Lane, in a paper on "Core Testing", "it takes from eight to ten times as heavy a load to break a core in tension as it would had the core been made 1 inch square and tested transversely on centers 1 foot apart, small flaws that might make but a small difference in the transverse work, will show up big in tensile tests. Also it is much easier to make small briquette shaped cores for the tensile tests than it is to make long cores and have them perfect throughout the entire length." Mr. Lane's paper also contained considerable detailed information on making core tests and was accompanied by illustrations of the apparatus necessary for this work.

E. A. Johnson, of Boston, Mass., pointed out some of the practical aspects of molding sand testing along the lines developed by the American Foundrymen's Association.

Foundry Cost Systems

"Put Your House in Order", a paper by Fred A. Parkhurst, Detroit, was an appeal for a more thorough study of the principles of scientific management by foundrymen. This paper was supplemented by a contribution on "Common Sense Foundry Cost Systems", by E. W. Riker, New York. Mr. Riker has developed a simple cost system based on weekly reports. The reports can be prepared without serious effort from data furnished by standard forms. Portions of this paper are as follows:

A cost system is rightly called the mainspring of the business, but it must be practical; and when installed it ought to be clearly understood that such a system is not automatic and that its value depends largely on the understanding the chief executive of the business has of its principles and its possibilities. The foundry cost system that is right and fits the foundry into which it is installed should not require special accountants to operate it, but just the ordinary foundry clerk who is practical by reason of his foundry education and experience and is, therefore, helpful to the foundry owner or executive because he will be practical and logical in his work and have his cost figures in such shape that they will give the exact facts when needed. This feature is mentioned here to convey to you the thought that if a foundry cost system is based upon the right principles and is appropriate to the foundry in which it is installed it can be operated economically. Therefore, accurate cost control of a foundry by economical methods is possible beyond the question of a doubt. A foundry cost system can readily be devised to fit the foundry for which it is intended that will absorb and account for every disbursement for material and labor, whether it is a direct or productive item or an indirect or non-productive charge. Furthermore, these disbursements may be separated to divisions or departments for efficiency in foundry management and still further be divided into classes of castings or to individual jobs or orders, to show complete cost of product by classes, by jobs, or by specific orders. All of this can just as well be tabulated and presented weekly, instead of monthly as is done in some foundries, and in a manner that is accurate, simple and economical.

The Thursday morning meeting concluded with an illustrated address by C. B. Connelley, dean of the Carnegie Institute of Technology, Pittsburgh. Mr. Connelley described the equipment, aims and policy of the Carnegie Institute in a detailed and interesting manner. Thos. D. West, of Cleveland,

THE SOUTHERN DELEGATION IN ATTENDANCE AT THE FOUNDRYMEN'S CONVENTION

Top row, left to right:—C. D. Randle, Wm. Rohlman, W. T. Mahoney, N. M. Tate, Geo. L. West, Mrs. N. M. Tate, G. A. Neal, B. F. Lively and H. Brown

Bottom row, left to right:—C. T. Martin, William Oberhelman, A. C. McFarlane, Geo. H. Kersting and J. Zipp

presented a brief paper recommending the adoption of a series of standard forms for reporting foundry accidents.

Simple methods of testing and analyzing foundry flour to determine its value as a core binder formed the subject of an interesting paper by G. S. Evans, Lenoir City, Tenn. Of the various constituents of value, starch and gluten are the only ones possessing any marked power of adhesion. Of the two, gluten is by far the most valuable.

Dr. Richard Moldenke, in a memorandum on centrifugal blowers for foundry use, gave the results of an efficiency test of a Rateau type blower built in Germany. These tests show an efficiency ranging from 73 per cent at 2 inches water pressure to 77 per cent at 5.2 inches water pressure.

Use of Powdered Coal

Facts of considerable interest to iron and steel engineers were contained in an illustrated paper on the use of powdered coal as a fuel, by W. S. Quigley, of the Quigley Furnace & Foundry Co., Springfield, Mass. This paper follows in part:

Today powdered coal is used in iron and steel plants for firing annealing furnaces, puddling, busheling, reheating, rod heating, upsetting, etc. For best results powdered coal must contain not over ½ per cent moisture and be ground so that 93 to 95 per cent will pass a 100-mesh sieve and 80 to 85 per cent a 200-mesh sieve. In that state the particles are so finely divided that each one, in a proper burning apparatus, is surrounded by the necessary amount of air for combustion and thereby liberates the entire fuel energy of the coal at once.

In a plant for properly preparing and burning powdered coal, a milling building from which the coal can be delivered to a crusher and reduced to the size required for pulverizing is necessary. From the crusher, the fuel must be elevated to a crushed coal storage bin, transferred from thence to a dryer and pulverizer and then delivered to distributing conveyors which supply the individual hoppers located near the furnace. The coal must be fed to the burners steadily and under absolute control.

The controller or device which regulates the coal feed to the burners is to the powdered coal furnace what the carburetor is to the gasoline engine. It is fastened to the bottom of a specially designed hopper or bin and consists of two screw conveyors. The upper one propels the coal forward to a point where it falls in a steady stream past the opening through which it is forced to the burner by a jet of low pressure air, the excess coal falling to the lower screw of greater pitch, which returns the overflow back to the base of the hopper. The controller screws are operated by either chain drive or are direct connected to variable or constant speed motors.

W. S. Hoyt, of the Oxweld Acetylene Co., Chicago, gave a lecture on oxy-acetylene welding and cutting, which was illustrated by numerous lantern slides. An article on this process as applied to foundry work was published in the October, 1913, issue of THE FOUNDRY.

The following papers were read by title: "The Pattern Shop as Related to the Steel Foundry", by E. R. Swanson, Commonwealth Steel Co., Granite City, Ill.; "Some Observations on Miniature or Detachable Open-hearth Furnaces", by W. M. Carr, Erie, Pa.;

PHILLIP MUELLER AND T. H. SCHUTZ TOOK AN ACTIVE INTEREST IN THE PROCEEDINGS OF THE A. M. I.

"Changing the Composition of Malleable Cast Iron", by P. Rodigin, Berdiansk, Russia; "A Study of the Annealing Process for Malleable Castings", by E. L. Leasman, Boscobel, Wis., and "Malleable Troubles", by Richard Moldenke.

Election of Officers

The annual election of the American Foundrymen's Association resulted in a unanimous choice of Alfred E. Howell as president for the ensuing year. Mr. Howell, who is associated with the Phillips & Buttorf Mfg. Co., Nashville, Tenn., served during the year as senior vice president. Dr. Richard Moldenke was re-elected secretary-treasurer by acclamation. Eight vice presidents were also chosen. They include: R. A. Bull, Commonwealth Steel Co., Granite City, Ill.; H. A. Carpenter, General Fire Extinguisher Co., Providence, R. I.; S. B. Chadsey, Massey-Harris Co., Toronto; G. R. Lombard, Lombard Iron Works & Supply Co., Augusta, Ga.; T. L. Richmond, Buffalo Scale Co., Buffalo, N. Y.; T. W. Sheriff, Sheriff Mfg. Co., Milwaukee, Wis.; J. J. Wilson, Cadillac Motor Car Foundry, Detroit, and Walter Wood, of R. D. Wood & Co., Philadelphia.

Before turning over his office to Mr. Howell, President Miles announced the following committees:

Papers.—Jos. J. Wilson, Detroit, Mich., chairman; L. L. Anthes, Toronto; H. M. Lane, Detroit; Thos. D. West, Cleveland; A. O. Backert, Cleveland; R. A. Bull, St. Louis; H. B Swan, Detroit; H. A. Carpenter, Providence, R. I., and H. E. Field, Pittsburgh.

Standard Foundry Costs.—H. D. Miles, Buffalo, chairman; the remainder of the committee to be appointed later.

Standard Steel Foundry Practice.—Dudley Shoemaker, American Steel Foundries, Indiana Harbor, Ind., chairman; A. H. Janssen, Davenport, Ia.; John Ploehn, French & Hecht, Davenport, Ia; Ralph H. West, Cleveland; L. A. Way, Coraopolis, Pa.; A. H. Thomas, Columbus, O., and R. A. Bull.

The usual vote of thanks were extended to the Chicago committee for its entertainment and to the authors of papers read during the convention. The place for the next convention was left to be settled by the incoming executive committee, although it is probable that the meeting will be held in Boston next June. The association definitely committed itself to a return to the spring meetings.

The convention concluded with the presentation of a handsome wrought silver pitcher to J. S. Seaman, the oldest living past president of the American Foundrymen's Association. The presentation address was made by Mr. Howell. Mr. Seaman replied with a few words that deeply moved every one present at the ceremony. He stated that he would make suitable arrangements so that the pitcher would always remain in the possession of the oldest living past president of the association.

A large number of the Associated Foundry Foremen were registered at the Chicago convention. The annual meeting of this organization took place Wednesday evening, Oct. 15. S. V. Blair, of the Kalamazoo Stove Co., Kalamazoo, Mich., was unanimously elected president, and H. M. Martin,

of the Davis Foundry Co., Hornell, N. Y., vice president. Robert B. Thompson, of the Buffalo-Pitts Co., Buffalo, was re-elected secretary-treasurer. The proceedings of the meeting, aside from the election, were entirely informal. Various phases of foundry practice were discussed.

The local committee at Chicago tendered the visiting foundrymen an enjoyable entertainment program containing a number of novel features. At the LaSalle hotel headquarters a buffet luncheon was served on Tuesday, followed by a special matinee at the LaSalle opera house. On this occasion a musical comedy entitled "A Trip to Washington", was presented. The stage was specially decorated in the first act with foundry tools and implements. On Thursday evening a large crowd enjoyed the annual subscription dinner at the Congress hotel. This banquet was somewhat unusual in that there were no set speeches, the entire evening being given over to a special vaudeville performance. Before the matinee on Tuesday the ladies were given a souvenir luncheon at the Marshall Field tea rooms and on Thursday evening attended a performance of "The Lady of the Slipper" at the Illinois theater. Mrs. Harry E. Pridmore, assisted by Mrs. F. S. Wayne, Mrs. Charles Dahlgren, Mrs. H. Cole Estep, Mrs. O. J. Abell and Mrs. Henry A. Pridmore, constituted the ladies' reception committee. Charles A. Plamondon, president of the A. Plamondon Mfg. Co., was chairman of the Chicago Foundry Convention Committee. Associated with him on the general committee were David R. Forgan, treasurer; H. Cole Estep, secretary; J. A. Galligan, O. J. Abell, C. B. Carter and William Francis. By special arrangement, practically all of the important shops and plants in Chicago and vicinity were open to visitors throughout the week.

The Production of Electric Steel Castings*

By F Snyder

THE following is a short statement of the present situation regarding the electric melting of steel for small castings. It refers entirely to the practice of melting cold steel scrap with electricity, as developed in commercial use in American jobbing foundries. Such foundries usually pour less than 10 tons of steel per day. The electric refining of steel previously converted in fuel furnaces for structural and tool purposes will not be considered.

Electric steel castings have been on the American market from a number of jobbing foundries for several years, and this use of electric furnaces for melting steel for small castings is rapidly spreading. The growth is due principally to the fact that steel in small quantities can, under usual conditions, be poured at a decidedly lower total cost from an electric furnace than from fuel-heated furnaces.

Quality of Electric Steel

A secondary reason for the growth of the practice is that the present quality of electric steel castings is somewhat better than the quality poured from fuel-melted steel. This improvement in quality does not as yet command an increased price, but operates to attract business to the foundries using electric furnaces. In the middle west the electric steel foundries ran to capacity through the months of this last spring when many crucible and converter plants were running on part time. It is practical with electrical melting at a small increase of the usual melting cost to produce castings decidedly better in quality than those now on the market as soon as the demand for such extra quality exists.

The improvement in quality of electric castings is primarily in the increased resistance to suddenly applied loads, making it permissible to use castings for parts subject to shock, such as auto truck brackets. The quality increase in this direction is large, electric castings standing two and three times the number of drop hammer blows required to break fuel-melted steel of the same carbon contents in the same pattern. The tensile strength of electric steel is 5,000 to 10,000 pounds higher than the fuel-melted steels for the same carbon. This is in part due to the higher specific gravity of the electric steel which in turn comes from the smaller volume of microscopic blow-holes.

The above table gives the general costs of electric steel in the middle west for the usual range of tonnages for 24 and 12-hour operations. Owing to the general practice of charging for electric power on a system of a primary demand charge per kilowatt plus a secondary consumption charge per kilowatt- hour, the cost of electricity per unit is much less for 24-hour operation than for 12-hour operation. A furnace loses heat during the night with 12-hour operation, which has to be put in again when the furnace starts up in the morning. These two items make the cost of 24-hour continuous electric melting decidedly lower than for 12-hour operation. This table refers to the operation of a specific type of furnace of high average efficiency and is based on the following charges:

Table I.

ELECTRIC STEEL MELTING; MIDDLE WEST CONDITIONS; PUBLIC SERVICE ELECTRICITY.

	Costs per ton melted.					
Hours run per day	12	12	12	24	24	24
Tons melted per day	4	8	12	5	10	20
Labor	$2.50	$1.25	$0.84	$2.80	$1.40	$0.70
Electricity	10.20	8.01	7.58	7.20	6.39	5.32
Supplies	1.94	1.17	.95	2.20	1.41	.88
Conversion cost	$14.64	$10.43	$9.37	$12.20	$9.10	$6.90
Scrap	10.90	10.90	10.90	10.90	10.90	10.90
Ferro-alloys	.60	.60	.60	.50	.50	.50
Melted metal cost	$26.14	$21.93	$20.87	$23.60	$20.50	$18.30

Labor— Per day
- Melter $5.00
- Assistant melter 4.00
- Helper 3.00
- Laborer 2.00

Electricity,
Primary charge— Basis
- First 100 K. W. ..... $15. per year
- Rest ..... 9.00 per year

Secondary charge ....7/10c per K.W.H.

Stock— 2,000 pounds
- Punchings $11.00
- Heads and gates 8.00
- Pig iron 12.00

*Presented at the Chicago convention of the American Foundrymen's Association.

Alloys—
Ferro-silicon $40.00
Ferro-manganese 50.00

Interest, depreciation, supervision and overhead are not included as they are about the same as for fuel-heated furnaces and differ widely from one foundry to another.

Pouring Electric Steel

The use of electric steel reacts to some extent upon the foundry practice. The electric steel can readily be made very hot, so that extremely thin sections can be poured if desired. Anything that can be poured in gray iron will run with this hot steel. Owing to the neutral chemical condition of properly made electric steel, it is quieter and less precautions have to be taken against blowholes from metal causes. The shrinkage is greater than with crucible or converter steel. More allowance has to be made on some patterns for machining. Owing to fluidity gates and heads can be made somewhat smaller.

Electric melting supplies a ready way of making alloy steels. The alloy can be added in the furnace. The electrical action causes sufficient movement of the steel to thoroughly mix the alloy. It has been found practical to remelt the heads and gates from alloy castings with practically no loss of alloy contents. With manganese steel this represents a substantial saving in cost of operation.

It is to be noted that the development in this electric steel melting for small foundries is in melting cold steel scrap rather than in using melted iron from a cupola. The principal reason for this is a matter of cost. It is usually cheaper to melt cold steel scrap than to use melted pig iron. Melted cast iron contains 265-kilowatt-hours of electric heat per ton. Against this apparent saving there are certain items of additional expense, which considerably more than offset the saving. Pig iron costs more than the steel scrap that an electric furnace can use. There is a higher metal loss. The pig iron that is commercially available is relatively high in phosphorus and sulphur, and the time required for refining out these impurities adds to the cost. To reduce the carbon within a reasonable time from pig iron values to the usual limits for steel castings requires the addition of iron oxide, usually iron ore. This leaves an oxidizing slag and requires a more skilled melter to pour quiet steel from melted cast iron, than from cold melted steel scrap. If this extra time and skill is not given when using melted cast iron, the loss of casting will be high. When melting cold steel scrap the loss of casting can be made lower than with any form of fuel melting.

The secondary reason for not using melted cast iron for electric steel which is not important at present, but promises to be commercially important when the demand arises for better grade castings, is that the less hot nitrogen that comes in contact with hot steel, the better the quality of the steel appears to be. The cupola blast is four-fifths nitrogen.

Table II.

EXTRA COST OF MELTED CAST IRON OVER COLD STEEL SCRAP 5 TONS PER 12 HOURS.

Cost of cupola melting		$0.80
Extra electric furnace time—		
Labor	$0.90	
Electricity	2.55	
Supplies	1.00	
		4.45
Stock—		
Pig iron, 2,150 lbs. at $13..$13.97		
Steel scrap, 2,050 lbs. at $11 11.28		
		2.69
		$7.94
Saving in electric power with melted cast iron, 265-kilowatt-hours at 1¼ cents		3.32
Extra cost, melted cast iron over cold steel scrap		$4.62

Some Difficulties in Pouring Steel Castings*

By R A Bull

IF THERE is one cause more than another which is periodically productive of the maximum annoyance to the man operating the steel foundry, and which gives trouble with less apparent reason for it at times, it is a leaking ladle. The writer has the frankness to introduce his subject with the admission that liquid steel deposited where it was not intended to go has many times disturbed his peace of mind. To others of his kind—and there are many such—he invites, for mutual benefit, a discussion of the factors pertinent to the topic, while offering a few suggestions experience has shown to be worth while.

Beginning first with the ladle as a unit and the necessity for keeping it suspended from the trolley—and this point will not be lost upon those who have seen a ladle of steel drop to the foundry floor—it is a most unsafe practice to use chains for the ladle crane. Wire rope has superseded the chain on the drums of most of the modern pouring trolleys, but not on all. The reason for the use of the rope is obvious. Many a poorly welded link shows no surface defect, while a wire rope gives warning of excessive wear and weakness by the parting of the outside strands. In these days of proper regard for the safety of employes the use of chain in carrying a steel ladle is on a par with the use of cast iron in the construction of the trolley itself, and is simply inviting catastrophe.

The Ladle Bail

Coming to the ladle bail, it is superfluous perhaps to say that it should be forged of the best possible material, and designed with a high safety factor. But more than that, it should be jointed so as to relieve undue strains caused by sudden or unexpected movements of the crane bridge or trolley. A stiff sling hooked over the ladle trunnion, rigidly attached to the cross-arm, is not conducive to the flexibility which is sometimes very desirable and which undoubtedly prolongs the safe life of the bail. The cross-arm should be provided with a shield to protect it somewhat from the heat underneath, and there should be an air space between shield and cross-arm. It is a good plan yearly to anneal the entire bail as well as the crane hook, to prevent crystallization.

In making up the stopper rod, great care should be taken in the use of keys for securing the stopper head. It is false economy to use a key more than once. A crystallized key may cause a heavy loss and the cost of a new one is negligible. The joints between the sleeves of the stopper rod, as well as those between the bricks of the ladle lining itself, should be carefully looked after for reasons not necessary to state. Sleeves, stopper head and nozzle should be selected with great care, to see that none is cracked or patched, and that the contour of the nozzle enables the stopper head to have a perfect seat. The black ring left by rubbing a graphite stopper head around a clay nozzle is proof of it.

Having made up the rod, of course, the clay joints should be well-dried, like the clay lining of the ladle bricks. And in drying the ladle itself many believe an upright position to be prefer-

*Presented at the Chicago meeting of the American Foundrymen's Association.

able. Undoubtedly the brick lining is thus less susceptible to displacement. Perfect lining would sometimes prevent those red spots which suddenly appear on the ladle plates, which are immediately followed by the melting of the latter and a very awkward breaking out of the metal. The nozzle must be carefully set and well rammed-in, and the lower portion should extend below the nozzle-plate sufficiently to enable the metal to clear the plate nicely and not become *gummed* at the outlet.

The setting of the stopper rod calls for nice adjustment under somewhat unpleasant conditions, and for this a careful, painstaking man is essential. This work I believe can best be done under the direction of the melter so there can be no division of responsibility. The mysteries of ladle-leaks, and consequent difficulty in fixing responsibility for bad spills, are quite sufficient at best without adding to the difficulties by inviting controversies, which sometimes prevent unbiased analysis of causes.

In tapping the heat, the additions should be of moderate size to enable reasonably quick melting and thorough distribution. Large lumps of ferromanganese, gravitating to the nozzle, may stick to the lip of the latter in a half melted condition, and cause a very bad shut-off. The melter should personally look after the size of the lumps constituting the additions, and the introduction of these into the ladle, which should be regulated by the nature of the tap.

Clean Shut-Off

Given a perfect heat and a perfect ladle, there should, of course, be a clean shut-off. But this is by no means always the case. The ladle man or steel pourer may inadvertently open up too strongly on his first task. Then if this initial mold is moderately small so as to fill quickly, the man whose hand operates the lever may have hot work cut out for him for a period. The steel pouring over the lip of the nozzle without any check from adjacent position of the stopper head may seem determined to flow regardless of the movement of the lever. This is due to chilled steel adhering to the nozzle, preventing a perfect seat, and caused by a tempestuous flow of hot metal in excessive quantity over a comparatively cold nozzle. A restricted flow, giving time for such a skull to melt away if it forms, is highly desirable on the first mold. Sometimes the stopper head may stick to the nozzle at the start and excessive pressure must be exerted on the lever with the result that the stream may open in greater volume than intended, through the sudden release.

Occasionally, through careless manipulation of the lever, a very small amount of steel may trickle from the nozzle, which in itself may be of no consequence. This must be closely guarded against by pinching the stopper head tightly at all times against the nozzle. An apparently insignificant dribble is very likely to cut the nozzle and produce a nasty leak. Once the nozzle begins to cut away, the teeming of the balance of the metal should be expedited with all possible dispatch by pouring the nearest and largest molds, for almost invariably the stream will soon become so large in area that the pouring cups will not accommodate it.

Use of Adjustable Lever

Sometimes the stopper head or the nozzle, or both, will wear away considerably during the pour, consequently increasing the height of the lever, and preventing the ladle man from handling it with skill. This may itself cause the steel to trickle, with the bad possibilities before mentioned. An adjustable lever to meet such contingencies is far better than a hastily moved, temporary platform on which to stand or a vertical addition to the end of the lever by means of a molder's shovel.

A prolific source of leaks is cold metal, which encourages the formation of skulls around the top of the nozzle. This cause is, of course, one easily determined and may give serious trouble during the early pouring. On the other hand, I have heard some foundrymen attribute bad leaks to the temperature of the steel being too hot. I have never felt satisfied with such an explanation, believing that the temperatures attained in the open-hearth furnace in regular practice are not sufficient to cause a leaky stopper, given a perfect ladle, with all that implies. Unquestionably the impact of the stopper head on the nozzle, with both in a highly heated state, will make them wear down. But if they are of good material and perfectly sound, such wear, as I believe, will be uniform.

I have seen leaks which experienced foundrymen have insisted were caused by the slag freezing on the top of the metal and binding the upper part of the stopper rod. I recall some of these where there was no possibility of definitely determining the cause, and where perfectly clean shut-offs were experienced at the start. Suddenly the lever would refuse to budge, without anything being jammed on the outside of the ladle, and finally come to the desired position, shutting-off the stream after considerable metal had been lost. Obviously, something had interfered with the operation of some part of the stopper rod, but I believe slag to be too fragile to resist the force applied to the lever. What produced the trouble could only be surmised.

I have not by any means enumerated all of the troubles experienced in pouring steel. Many of us have seen stopper rods burn in two, stopper heads burn off, and stoppers stick so tightly to nozzles that *prickers* had to be resorted to to open them. It may be mentioned, in passing, that wooden prickers are to be preferred, as they will not fuse to the semi-plastic metal sometimes present in the nozzle orifice. An ordinary gate-stick is always available and will generally force an opening.

I have not mentioned the skill requisite in pouring a perfect heat from a perfect ladle, to guarantee the best possible results in the castings. This is an important matter, and if not given the needed attention may throw the blame for mis-run and cracked castings on the shoulders of the melter unjustly. A knowledge of the design of the mold itself, the manner in which it is gated, the approximate weight of the casting, have a direct bearing upon the proper control of the stream. Insufficient feeding of heavy sections is not only productive of shrinkage cavities, but also, according to my observation, of shrinkage cracks, when the cavities may not be in evidence. A large number of risers of moderate size enables better feeding than does a small number of very heavy sink-heads. Regardless of how, these may be designed or placed, the ladleman should hold his ladle over the mold till the risers are solidified past all hope of further feeding. Naturally, a leaky stopper presents complications in so doing.

The difficulties herein mentioned are only a few of those that attend the transfer of steel from furnace to mold. It may be admitted that today bottom-pouring in general is a very neat mechanical manipulation. Nevertheless, all of us have an occasional bad heat to handle and need others' experience to draw from as well as our own. But despite all the help available from his colleagues, the steel founder must, by his own experience, work out many ladle problems for himself, and should constantly study the art of pouring, realizing in direct proportion as he does this, its great importance.

Lockwood, Greene & Co., architects and engineers for industrial plants, 60 Federal street, Boston, have established a Canadian office under the firm name of Lockwood, Greene & Co. of Canada, Ltd., with headquarters in the McGill building, Montreal.

How to Overcome Troubles in Malleable Shops*

Low and High Heats and Various Mixtures Discussed

Melting in the Cupola and Air Furnace, Also Annealing

By Richard Moldenke

THAT the troubles incident to the production of malleable castings are far more trying than those experienced in other branches of the iron foundry is due to the fact that about half the material melted consists of shop scrap. Any deficiencies in the stock purchased or in the metal produced through poor practice ingrafts itself upon the scrap, and unless promptly diagnosed and corrected becomes more aggravating from day to day, ending in serious commercial disaster. The unfortunate phase in the situation is that once the trouble has been located and corrected, the malleable man has the disagreeable prospect of taking a week's work from the ovens, all of which he knows to be of inferior quality.

In spite of the fact that the malleable process has not been changed or much improved since the earliest times—simply because radical changes in the heat treatment applied takes the material entirely out of this class of castings—the subject requires a life study, and even with such an experience much that occurs must be left to scientific speculation. With the constantly increasing researches being made into this fascinating subject, there is reason to believe that we may soon know more—provided that the students base their conclusions upon actual practice combined with laboratory research, and not the latter alone.

Low and High Irons

The two principal characteristics of bad malleable castings are the so-called *low* and *high* irons. In the range of malleable work, depending primarily upon the silicon content, thickness of section, and to a smaller degree, the temperature of the metal poured, there will be found on one end of the series the extremely weak, gray fractured metal, absolutely ruined through oxidation in annealing the hard castings. This is sometimes so open in structure, through oxidation of the graphite which should not have been there, that on breaking a piece of this extremely *low* iron, the fracture is highly colored with bands of blue, red and yellow alternating through it and showing up the arrangement of the crystallization scheme very nicely. This calico iron is perhaps the very worst trouble the malleable casting producer can have, for it is more dangerous than the commonest cast iron.

From it—as the disposition of graphite in the original hard iron becomes less and less—we get the malleables that approach ordinary gray iron in strength, and might as well have been made in the cupola and not annealed. We have malleables which are eminently suitable for work which must be machined like cheese, and yet be soft enough not to fracture under shock too readily. As for instance, air brake light parts, and in the better grades, pipe fittings. Metal of this kind is, however, made quite specially—in separate heats—as getting this material into important work is too serious a question.

Range of Iron From One Heat

The range of malleables now comes into the good work, and here there is a fair chance to get heavy and light work from the same heat, if the proper portion of the bath as it empties out of the furnace is caught. This naturally relates to furnace iron and not cupola work. We have here the two characteristics of white iron to make use of. Granted that there is a slight lowering of the silicon during the tapping process, as it usually takes one-half to one hour to get out the ordinary heat, and the heat itself having been ready to pour into castings when tapped, the first part, with higher silicon, would be more suitable for lighter castings than the last, if hot enough to pour at all, whereas the last iron, even if ordinarily too high in silicon to be safe if poured cold, will come out all right on account of the extremely high temperature existing in the metal at the end of a heat.

Very light castings, of course, must be poured from the hottest iron made, and hence the works in which the heavy range of car castings are produced have their difficulties in making iron suitable for strong, heavy castings, and yet turn out quantities of very light castings with the same metal, and with consequent heavy losses from mis-runs, blows, etc.

Low Silicon Mixtures

I have always felt that the solution in cases like this is to make the mixture low enough in silicon to suit the heavy work. Tap out that portion of the heat, close up the breast, add ferro-silicon enough to the bath to bring the metal to a silicon content proper for very light work, allow to heat up properly, and tap again to pour all the light castings. I may say that this method of procedure is recommended with much reluctance, as there is nothing worse than having to add silicon to a heat of malleable where strong, heavy-sectioned *specification* metal is wanted. This is never necessary unless the heat has been run wrong in the first place, or the bad policy of using a furnace larger than 20 tons capacity has been adopted. Metal in melting is under oxidizing influences all the time it is in the furnace, and hence it should be the aim of the melter to get his metal under a slag cover as rapidly as possible. Next, it should be heated as rapidly as the furnace will permit, and finally it should be tapped out as fast as men can take it away.

Given a heat melting in say two hours longer than the normal, there is a gradually increasing percentage of iron oxide dissolving in the bath, while the silicon content is lowering abnormally. Adding ferro-silicon, while intended to restore the silicon content,

*Presented at the Chicago convention of the American Foundrymen's Association.

and actually doing this, also deoxidizes the bath. This looks good on the face of it, but unfortunately the products of this deoxidation have a way of not rising to the top very quickly, but remain scattered throughout the bath of metal and go into the castings. Here we have a theory which does not work out, and the reason is that malleable temperatures are too low. In the case of a steel casting heat we have a temperature hundreds of degrees above that of malleable—which in even the hottest condition is lower than ordinary heat for gray iron work—and consequently the deoxidation is rapid, and the slag formed rises out of the metal in time for efficient use. That this is not the case in making malleable I know not only from actual pyrometric readings of the metal taken in the furnace and just before pouring the molds, but from years of records of tensile and transverse tests made on the first and last portions of thousands of heats. I claim that the addition of ferro-silicon to heats lowers the value of the metal for making castings. You can prove this by taking a series of observations, not isolated cases, on test bars cast from the first and last of heats—not the middle. Furthermore, by taking not ½ square, or ⅜-inch round bars, but good big inch square test bars. These will tell the story without having you deceive yourselves.

Malleable Melting

The practical application of the above lies in your melting arrangements. A malleable melter knows how to distribute his charge in such a way that it melts in the shortest time possible. A steel melter dumps the charge in incongruous heaps. The result is a heat longer by at least half an hour for the same tonnage. The malleable melter works his metal to promote uniformity in temperature and acceleration in getting ready for the test and then the tap. The steel melter sits down and lets the heat simmer. When his test eventually shows that the silicon has gotten too low, that is, the plug shows white iron throughout, with fine pin holes along the rim, he adds ferro-silicon and sits down again. When hot he taps. The comparison between the two methods is best shown from the fact that, say, a 10-ton heat from the air furnace takes a malleable melter not over four hours to get ready from end of charging to time of tapping. The same heat will often take the steel melter seven hours.

To recall my own practical experience, I will mention that for years, with self-trained malleable melters the tensile strength of daily heats ran up to 51,000 pounds per square inch, and the same 1-inch square test bars would bend up to 2½ inches before failing. Then a steel melter was given charge of the furnaces, the heats soon increased in length, ferro-silicon was added as a common occurrence, and the average strength of the test bars dropped to about 43,000 pounds per square inch. Moral—keep steel melting methods out of the malleable shop, watch the firing so that a uniform stream of intensely hot flame heats up the brickwork of the roof and side walls of the furnace, and no cold air puffs from open furnace doors check this temperature any more than may be necessary.

High Irons

As the silicon content in the metal becomes lower, the heats longer than necessary, and the metal hotter, signs of gas formation begin to show within the structure, noticeable more particularly on the surface of the castings. The fracture, instead of showing the characteristic fine band of white for the skin, next the ⅛-inch band of gray to black where the crystals of iron have arranged themselves at right angles to the surface planes, and then the black interior, it begins to show a broader band of white, indicating that by reason of a more open structure the oxidation effects of the packing and air currents in the saggers have penetrated more deeply into the castings. The castings are weaker, the surfaces not as smooth, the edges become rounded, in bad cases the metal has wasted heavily by scaling off, and as this trouble progresses, the material finally becomes brittle and unsalable. At all times, however, so long as there is an annealing action, the metal is not as bad as *low* iron. Hence it is better to err on this side of the series than on the high silicon side.

Now, unfortunately, it is quite possible to have *burnt* iron, with the proper silicon content, and that brings us to the melting problem. Before going into this, however, it may be stated that when the silicon gets so low that the hard castings are full of blow-holes, molds become short-poured even with very hot metal, and there is no sign of annealing effects on taking from the ovens, the other end of the series will have been reached.

As there is no establishment that sooner or later does not make all of the above described varieties of malleable, I would suggest that a cabinet of fractured pieces be established in the superintendent's office, preferably the broken test bars of 1 inch square section where heavy work is to rule, and 1 x ½-inch where very light work is made only, and that gradually the series from very *low* to very *high* malleable be accumulated. Some 30 pieces, each one showing a shade different from the next, can thus be had, and this series forms the best kind of a sermon for the edification of the foremen and melters when things go wrong. Moreover, a watchful manager strolling through the shop can pick up a few castings, have them broken, and compare fractures with this standard series of *bad to good* and *good to bad* in a line.

Variations in temperature and time in the anneal may ruin a good, hard casting, but not even the best annealing practice will make a poor hard casting into a good piece of malleable. Hence, before condemning the annealer it is always well to look into the melting practice first, presuming that normal irons and scrap have been used.

Melting in the Cupola

In melting iron for malleable in the cupola nothing more can be said than that the precautions to be taken for gray iron apply here more particularly, as we deal with very low silicons. Here the charges must be small to avoid fluctuations in the position in the melting zone, and moreover, it is necessary to melt quite high in the melting zone, in order to keep away from every possible chance of oxidation. Hence, a low fuel efficiency is essential.

In the case of the air, as well as the open-hearth furnace, the first thing to watch is the charging. The careful melter so disposes his charge that the sprues melt first and form a pool of iron into which he can throw one pig after the other from two piles carefully laid in regular order as if in the stock yard. If possible, these piles should be spread over the furnace bottom somewhat so that they heat up in quickest time. But they should be laid perpendicular to the side walls, so that an iron bar inserted into the furnace will push one pig at a time into the bath as desired. There seems to me nothing more unsatisfactory and inefficient than to see a melter try to loosen up a pile for this purpose and perhaps break off a little at one end of a softening pig, the other sticking fast within the pile. Naturally, he gives up when physically exhausted, and nothing of value is accomplished. The pile simply has to melt down of its own accord and not assisted by the melter. The result, however, is that the heat is longer,

coal is burned unnecessarily, and worst of all, the iron is injuriously affected.

Next comes the firing itself. In the case of the open-hearth furnace, with gas or oil-firing, the problem is simple enough for this end of the operation. The care of the furnace is another matter. In the air furnace, however, the greatest possible attention should be given to this problem. As in boiler practice, the best results are obtained by clockwork-like precision of opening the door, inserting coal close to it, closing to allow the coal to begin coking and at the same time giving off gas to pass over the hot bed of fuel, then opening the door and pushing the coals over the fire bed, etc.; so also in air furnace practice this routine should be followed. There is this extra precaution, however, in the latter case. In boiler practice about 100 per cent air in addition to that theoretically required is allowed to enter, and thus the maximum value of the coal is obtained. In air furnace practice, however, where we need extreme temperatures rather than high fuel efficiency, not more than 25 per cent extra air should be allowed into the fire-box end of the furnace, otherwise the heat will be prolonged unduly. It is not the flame that does the best melting, but the radiation from the incandescent brickwork of the combustion chamber of the furnace, which means that a surface as unbroken by defective doors, etc., as possible, heated up to the highest degree safe for the bricks, and kept that way steadily by a stream of uniform fire should be presented to the metal charge. In how many establishments is this the rule? I have seen but few myself. There is more room for improvement here than anywhere else. An efficient furnace charging door now on the market, in which it is impossible to open the door at all while firing, has solved this problem nicely. In spite of this excellent arrangement, I cannot help but feel that for the class of coal always used for melting with the air furnace, the chain grate is the coming solution of the firing problem where the necessities of the establishment require the air furnace. Where a plant has steady occupation for a furnace the year around, the open-hearth furnace is the ideal melting medium.

Long heats, through poor firing, or inexcusable composition errors in these days of chemical laboratories, mean iron that goes to the anneal with every chance of poor results. To this should be added that even with the best of hot iron running from the spout, if a shank of, say 150 pounds, has to be carried to the other end of the shop before pouring a heavy-section casting, trouble is almost certain to result from *low* iron. Hence judgment should be used in placing the patterns, so that only hot iron may go where it is most needed.

While *low* iron usually pours like gray casting work—that is, with a minimum molding loss—even though the castings themselves are worthless, *high* iron, on the other hand, gives rise to a variety of casting troubles, such as shrinks, cracks, pin holes, blow and gas holes, etc. The molding loss sheets show astonishing black spots for castings that are sensitive to variation in the iron. There is only one grade of iron right for the malleable shop, and this grade can readily be made if the executive knows how to compel its production.

Annealing Troubles

While scientific investigation in laboratories shows all kinds of errors committed by the practical malleable man in keeping time and temperatures of the ovens as he has them, yet we all know the fate of establishments where quick anneal and high temperature practice has prevailed. The sheriff gets them. Unless, indeed, the Reaumur or Continental European process is used—where temperatures and times of anneal are used which practically decarbonize the metal (and thin metal only at that) so that the fracture is a steely white—the good old process taking 60 hours of full temperature of around 1,350 degrees Fahr. for the coldest pot in the coldest part of the oven should be used. Then one knows that when the iron from the molding floor comes to the anneal, it will issue nicely and as a good material. If oxidized in the melting, no skill of the annealer can correct this.

The two troubles incident to annealing practice are *over-anneal* and *under-anneal*. The former, by running the temperatures too high, so that the metal opens up and the fracture shows heavy white bands, if not entirely white (but steely and not crystalline as in the hard casting); and the latter, by showing but an imperfect change from the crystalline structure of the hard casting to the fine soft gray of the good malleable casting. It is sometimes quite difficult to distinguish the two, particularly when a casting is almost fully annealed. On closely observing the character of the white rim, however, the distinction can be made, for when over-annealed the white band does not show sharp interior corners, but rounded ones, which, as the band goes inward further, eventually leaves the black-heart a round spot. A comparison of a number of fractures from the same oven will show a range of pieces which tells the story, as in the case of over-anneal there will be few good pieces, and none with the original hard structure, while with under-anneal there will be good castings and a few hard ones. In the latter case the whole charge, or at least the coldest pots, can be returned for another anneal. In the former there is no help.

Ratio of Coke to Iron

By W. J. Keep

Question:—Our cupola is lined to 66 inches and we operate with 7½ ounces blast pressure. The bed consists of 900 pounds of coke and each of the three iron charges consists of 3,000 pounds while the last charge is reduced to 2,500 pounds. We make four coke charges as follows: 600, 300, 300 and 200 pounds. The totals, therefore, consist of 2,300 pounds of coke, 5,000 pounds of pig iron, 4,400 pounds of remelt, 1,100 pounds of machinery scrap and 1,000 pounds of stove plate scrap. We use 2,300 pounds of coke to melt 11,500 pounds of pig iron at a ratio of 1:5. While the stove plate castings we produce are satisfactory, we would like to know whether we can reduce the coke consumption.

Answer:—Your bed consists of 900 pounds of coke, plus the 600 pounds which you indicate as the first charge, amounting to a total of 1,500 pounds. On the other hand, if you choose to separate that portion of the bed which is used merely to hold the charges up to the melting point, the bed would consist of 1,200 pounds with each of the coke charges 300 pounds. You cannot reduce the fuel bed, and with 3,000 pounds of iron to a charge with 300 pounds of coke, your melting ratio is 10:1, which is as low as you can go with so small a bed and only four charges. On your last charge you had 200 pounds of coke to 2,500 pounds of iron, a ratio of 1:12½. This cupola should melt 28 to 32 tons of iron and at the same rate that you are now running you would melt at a ratio of 10:1. Using so large a cupola for so small a heat, a 5:1 ratio is good melting practice. Your blast pressure is low, but your tuyere capacity probably is large enough to deliver the proper quantity of air, otherwise you would melt slow. The ordinary pressure for a cupola of this size is 14 to 17 ounces. The melting capacity should be at the rate of at least 10 tons per hour.

Gray Iron Mixtures for Motor Car Castings*

A Comprehensive Discussion of the Problems of the Gray Iron Founder Specializing in Automobile Parts, With Mixtures That Produce Good Results

By H B Swan

THE subject of cast iron as related to motor cars covers a much wider field than the scope of this paper will permit. Cast iron and steel are the materials which are by far the most extensively used in the mechanical parts of the car, although malleable iron does enter into consideration to no small extent. Such a vast amount of research work has been done on steel that the selection of a composition chemically and physically most suitable for the kind of service demanded of it no longer is a matter of guesswork. Perhaps not to the same degree, but still vastly important, is the selection of the proper composition of metal most suitable to meet the duties required of the parts made from cast iron.

FIG. 1 — IRON NO. 1, POLISHED
Magnification 50 diameters

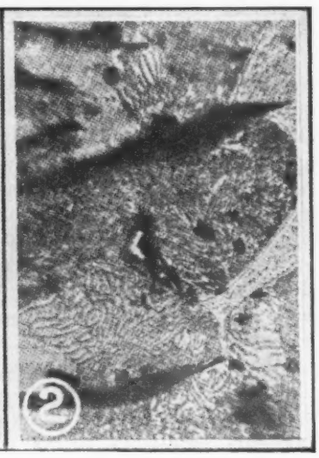


FIG. 2—IRON NO. 1, ETCHED
Magnification 1,000 diameters

The building of motor cars has become a science and the automobile engineer demands castings of a maximum strength with a minimum of weight. The design of the part may be of such intricacy as to produce conditions which tend to cause defective castings. He further specifies that the castings shall conform within limits to a certain chemical composition and be free from the numerous characteristic foundry defects. Moreover, the machine shop demands that they shall cut readily. This does

*Presented at the Chicago convention of the American Foundrymen's Association.

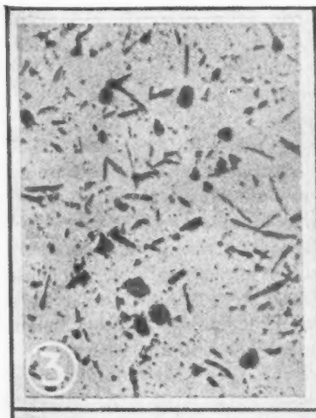


FIG. 3 — IRON NO. 2, POLISHED
Magnification 50 diameters

FIG. 4 — IRON NO. 2, ETCHED
Magnification 1,000 diameters

FIG. 5 — IRON NO. 3, POLISHED
Magnification 50 diameters

FIG. 6 — IRON NO. 3, ETCHED
Magnification 100 diameters

FIG. 7 — IRON NO. 3, ETCHED
Magnification 1,000 diameters

FIG. 8 — IRON NO. 4, POLISHED
Magnification 50 diameters

FIG. 9 — IRON NO. 5, POLISHED
Magnification 100 diameters

FIG. 10 — IRON NO. 5, ETCHED
Magnification 100 diameters

not necessarily mean that the castings shall be soft, although metal too hard or having hard spots is bad for machining. In the opinion of the writer, there is a discrimination between hardness and cutting qualities, judged from the standpoint of the life of the tool.

It is the practice in the foundry with which the writer is associated to pour several test bars of each kind of iron daily. These test bars are ½ inch square and represent, to a fair degree, a section of the castings made, and are used in connection with Keep's test. After being broken for transverse strength, they are ground to a smooth surface and tested with a Brinell machine for hardness. It has been a matter of careful observation and interest to note that while the chemical composition and hardness as represented by these daily test bars may not vary to but a slight extent, cutting qualities of the iron seem to fluctuate materially. As a rule, the amount of combined carbon present gives a good indication of the hardness of the metal, but inasmuch as experience has shown us that the metal may be hard to machine, that is, hard on the tools even when the combined carbon is present only in a normal amount or less, it seems that there must be other factors to consider. Is it not possible then that the crystalline structure may have something to do with the machinability of the metal?

Uniform Quality

Since the machine shop operations are usually on a piece-work or premium basis, the importance of keeping the quality of the metal uniform is readily understood, for if the metal is hard uniformly or has hard spots, or is hard on the tools, it means a slowing-up of production and a loss of both time and money to the manufacturer and the foundryman.

Let us consider some of the motor parts made from gray iron. For many reasons the cylinder has been most widely discussed. Often it is of complex design. It may be cast as a single unit with or without a water jacket. Twin cylinders are common and three, four and even six *en bloc* are met with frequently. Of late it is the practice to cast the cylinders *en bloc* and integral with the engine base. Under such conditions light sections join with those comparatively heavy and it is not an easy task to select an iron of a composition that will run well, be sound and free from spongy spots, leaks, etc., and meet other requirements. Another question to consider is the wearing qualities of the iron. It would seem, for instance, that it not only would be interesting, but of value, to know more about the relation between the cylinder and the piston ring in connection with their wearing qualities, hardness and chemical composition. The laboratory of the company with which the writer is affiliated recently has purchased a machine for the study of these conditions and it is hoped that information of considerable value will be obtained.

Table I.

CHEMICAL ANALYSIS OF ELEVEN GRADES OF PIG IRON TESTED.

No. of iron.	Combined carbon, per cent.	Graphitic carbon, per cent.	Total carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulphur, per cent.	Silicon. per cent.
1	0.50	3.06	3.56	0.55	0.114	0.022	1.99
2	0.53	3.12	3.65	1.15	0.399	0.044	2.17
3	0.53	2.97	3.50	0.72	0.230	0.018	3.18
4	0.38	2.84	3.22	0.90	0.531	0.013	3.42
5	0.63	2.67	3.30	1.12	0.951	0.019	2.05
6	0.60	2.40	3.00	0.33	1.405	0.047	1.63
7	0.41	3.01	3.42	0.54	0.736	0.025	2.47
8	0.00	2.16	2.16	0.87	0.443	0.041	8.88
9*	3.63	0.55	4.18	1.18	0.044	0.001	0.49
10	Trace	3.52	3.52	0.42	0.409	0.027	2.53
11	0.32	3.07	3.39	0.21	0.404	0.038	1.41

*No. 9 also contains 1.05 per cent nickel and 2.17 per cent chromium.

It readily may be seen that a cylinder iron, depending on conditions, may possess characteristics entirely at variance from those suitable for a flywheel. If the flywheel rim is to be cut with gear teeth its properties may closely approach those of a cylinder in that it should be sound, strong, and possess good wearing qualities. For piston rings we have found that the best results are obtained with an iron high in phosphorus and low in manganese. This iron has the spring-like quality desirable for this part and is not too brittle to withstand the test demanded of it, provided the phosphorus does not run higher than about 1.15 per cent. Its hardness depends upon the hardness of the cylinder in which it is to run; that is, it should be a few points higher on the Brinell scale than that of the cylinder, for it must stand more wear. Engine bases and transmission cases should be strong and more ductile than other castings, for usually when made in cast iron they are made as light in section as is allowable, and with the rapid cooling around dry sand cores, internal strains are often set up which may not develop into cracks that are noticeable until subject to the vibration of the motor and the jolting of the car. This may be remedied by the choice of a proper composition of metal not too high in phosphorus and by the use of charcoal iron.

Table II.

CHEMICAL ANALYSES AND PHYSICAL TESTS OF FOUR GRAY IRON MIXTURES.

Class of iron.	Piston ring, per cent.	Cylinder, per cent.	Flywheel, per cent.	Soft, per cent.
Combined carbon	0.60–0.70	0.50 –0.60	0.60 –0.70	0.30 –4.40
Graphitic carbon	2.40–2.75	2.25 –2.80	2.25 –2.60	2.75 –3.25
Manganese	0.25–0.35	0.65 –0.75	0.60 –0.75	0.60 –0.75
Phosphorus	1.00–1.15	0.40 –0.45	0.40 –0.45	0.45 –0.55
Sulphur	0.08–0.10	0.075–0.095	0.075–0.095	0.075–0.095
Silicon	1.80–2.00	2.10 –2.25	1.80 –2.10	2.40 –2.60
Physical test results:—				
Tensile strength, lbs. per sq. in.	29,190	35,780	37,400	27,020
Transverse strength, lbs.	2,680	3,710	3,500	2,720
Shrinkage	0.15–0.16	0.155–0.16	0.160–0.165	0.148–0.154
Depth of chill	0.10–0.20	0.10 –0.20	0.15 –0.25	0.00 –0.10
Brinell hardness	228–235	207–212	212–217	174–187
Per cent steel in mixture	0–10	10–15	20	.....
Per cent scrap in mixture	50–60	50–55	45–50	50–60

Semi-Steel Mixtures

It is almost general practice among automobile foundries to use varying percentages of steel scrap in their mixtures, ranging from 10 to 40 per cent. It is claimed that the strength increases with the addition of the steel up to the latter amount. This undoubtedly is true if the chemical composition is regulated accordingly, but it has been found in our class of work requiring hot, fluid iron, that the silicon and phosphorus have to be increased to such an extent that the increase in strength is discounted. The increase of these metalloids likewise seems to be deleterious to the machining qualities and softness, and the high amount of steel tends to increase the chilling qualities of the iron to a prohibitive extent when used in con-

nection with the amount of scrap iron necessary for economical production. Turner states that best machining qualities and softness are obtained with a silicon content of about 2.5 per cent, although the maximum tensile and transverse strength are reached between 1.75 and 2 per cent. It has been found that a silicon content of 2.5 per cent with manganese 0.6 to 0.7 per cent and phosphorus about 0.5 per cent gives a good iron in every respect for lighter castings. For cylinders and pistons the introduction of 10 to 15 per cent steel and lowering the silicon content to 2.15 to 2.25 per cent it is practical and economical in the long run to divide the different types into classes, three or four in a number, and pour them with the metal best suited to meet the conditions, both from the foundry standpoint and from that of the metallurgist.

As a whole, automobile castings are classed as light work, but, as previously stated, much of it is intricate. It is not always practical or convenient to use chills, and if these castings could be poured with an iron which would be close-grained and free from draws, sponginess and segregation, losses could be reduced materially. Of course, there are numerous other important factors to consider which will aid in the production of such an iron, such as the manner of gating the castings. For instance, a piston cast with the bosses solid is much less liable to be spongy if gated around the circumference between the bosses.

To gain some insight into the vagaries and inconsistencies of cast iron and to correlate, if possible, the chemical composition and rate of cooling with the physical properties such as strength, hardness, resistance to wear and machinability, a line of experiments dealing with different brands of pig iron and varying percentages of steel was undertaken. It seems reasonable to suppose that the crystalline structure of the metals as well as chemical composition is linked with some of these properties. Therefore, in each experimental heat of iron poured, and from each pig iron used in the mixture, microphotographs were made from the test bars and from sections of the pigs.

Through this study and by means of experimenting with various mixtures, it is hoped that a better iron will be produced to meet the requirements of motor car castings. Theoretically, an iron with a pearlitic structure predominating and the excess carbon in the amorphous or temper form would seem to be most desirable. When, however, one considers the large number of variable factors which may influence the structure of the iron, the scope of the problem to be studied can be realized.

We have not done sufficient work to feel warranted in drawing definite conclusions. While the value of the experiments is still speculative, Table III is presented for whatever interest it may have to the foundryman, show-

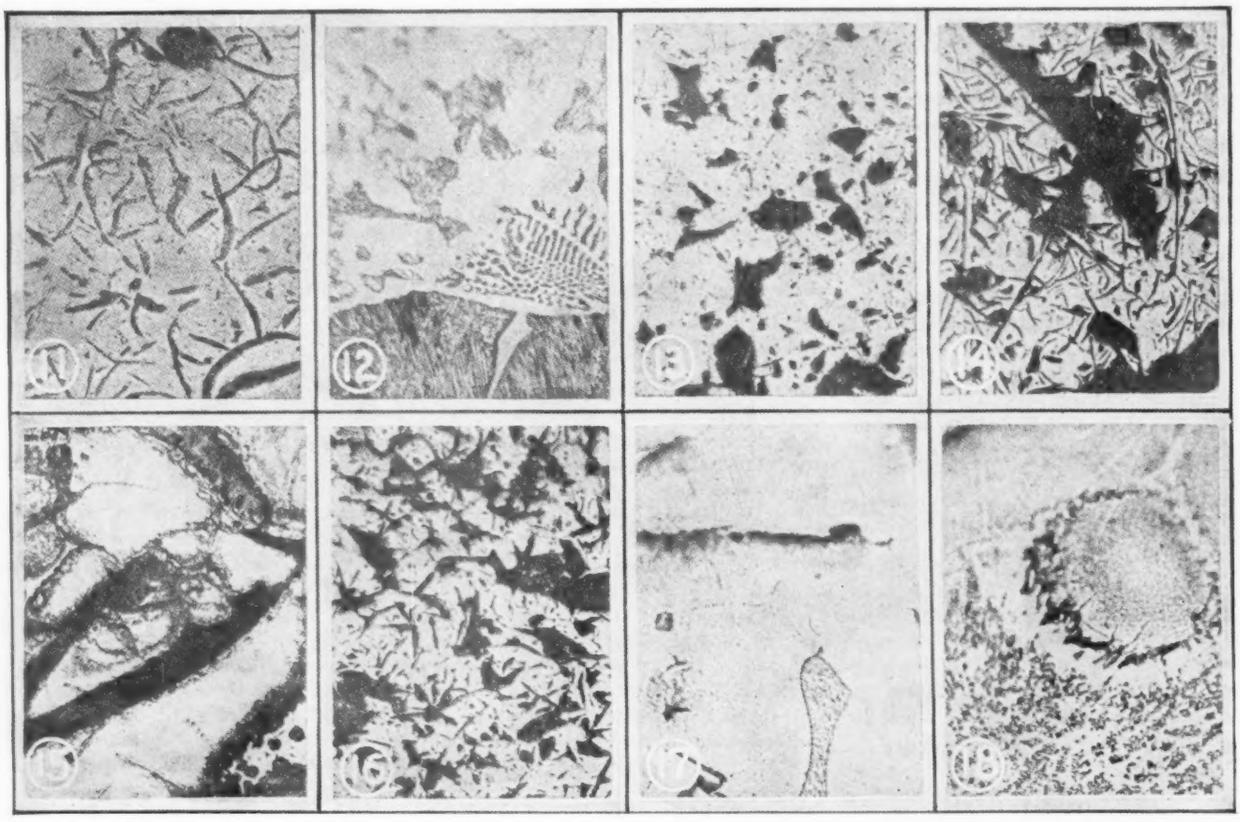


FIG. 11 — IRON NO. 6 POLISHED
Magnification 50 diameters
FIG. 15—IRON NO. 7, ETCHED
Magnification 500 diameters

FIG. 12—IRON NO. 6, ETCHED
Magnification 1,000 diameters
FIG. 16 — IRON NO. 8, POLISHED
Magnification 50 diameters

FIG. 13 — IRON NO. 7, POLISHED
Magnification 50 diameters
FIG. 17—IRON NO. 8, ETCHED
Magnification 1,000 diameters

FIG. 14 — IRON NO. 7, POLISHED
Magnification 50 diameters
FIG. 18—IRON NO. 8, ETCHED
Magnification 1,000 diameters

increases the strength materially. For flywheels and heavier work, not machined at a high speed of cutting, steel is increased from 20 to 25 per cent and the silicon lowered to between 1.8 and 2 per cent. This gives a strong iron which also is suitable for gear teeth.

It is important, therefore, that a grade of metal best adapted to meet the requirements of service be chosen for the type of casting to be made. Of course, it is not necessary or practical to run heats of a composition especially designed for each of the numerous castings for motor cars, but

ing in a condensed form the results obtained from mixing the various irons contained in Table I. Table II gives some data on the various irons used by the writer for different classes of automobile work.

For ascertaining the soundness of the metal, four castings of a large single cylinder were poured from each heat. The barrel of the cylinder being light in section, with the outside encircled by a heavy flange having a large boss on the cope side, presents excellent conditions for spongy metal. Whether the castings were sound or spongy is shown in Table III.

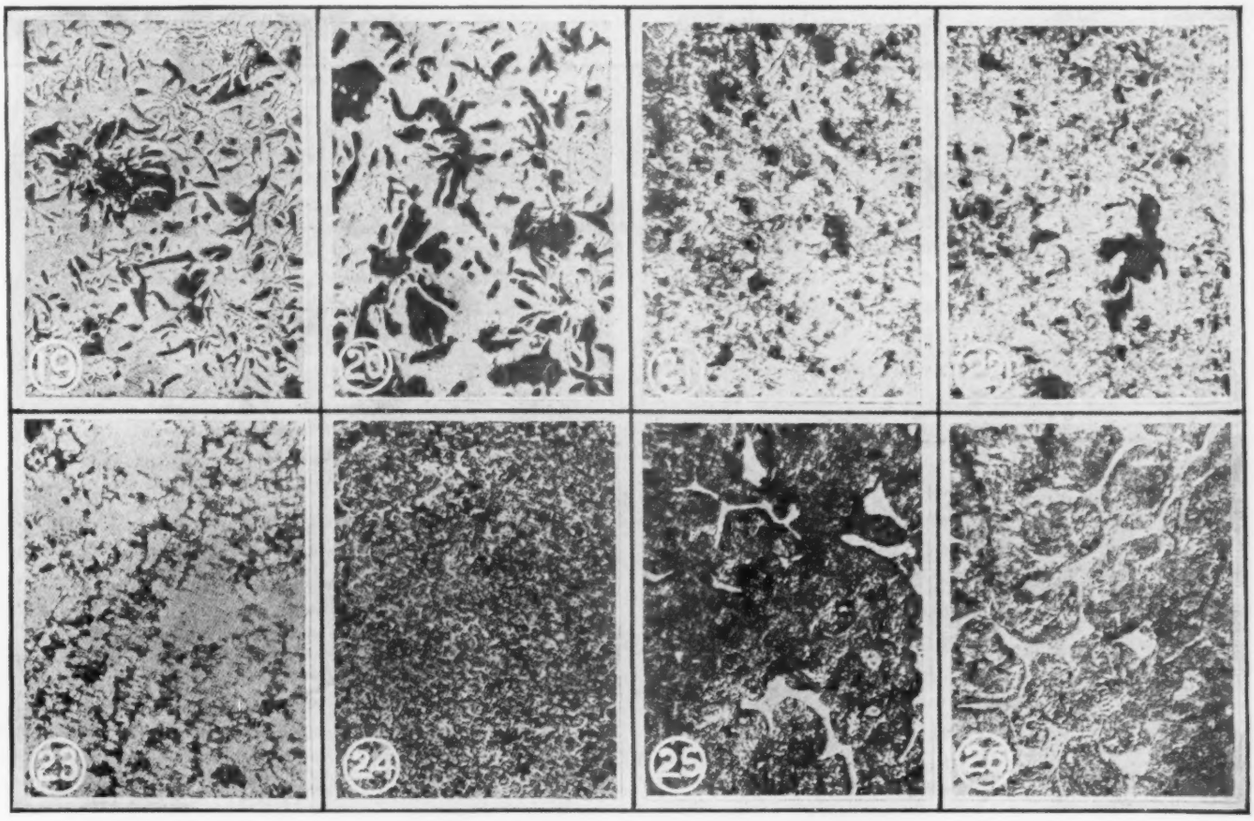


FIG. 19 — IRON NO. 10, POLISHED
Magnification 50 diameters

FIG. 20 — IRON NO. 10, POLISHED
Magnification 50 diameters

FIG. 21—SOFT IRON, ETCHED
Magnification 100 diameters

FIG. 22—PISTON RING IRON, ETCHED
Magnification 100 diameters

FIG. 23 — FLYWHEEL IRON, ETCHED
Magnification 100 diameters

FIG. 24 — CYLINDER IRON, ETCHED
Magnification 100 diameters

FIG. 25—IRON, HEAT 14, ETCHED
Magnification 500 diameters

FIG. 26—IRON, HEAT 15, ETCHED
Magnification 500 diameters

Table I is a compilation of different brands of pig iron used by the foundry with which the writer is associated and shows the various chemical compositions. Iron No. 1 is a northern charcoal brand; Nos. 2 and 5 are Virginia irons; Nos. 3, 4 and 7 are northern coke irons; No. 6 is a southern iron; No. 8 is a silvery iron; No. 9 is a Cuban iron of special composition, containing, in addition to the usual elements, chromium and nickel and traces of vanadium and titanium; Nos. 10 and 11 are charcoal irons from the New England states.

Fig. 1 is a microphotograph of the No. 1 iron, the sample being polished and magnified 50 diameters. The rosette-like structure of the graphite is peculiar to this charcoal brand. A close inspection also reveals the presence of the iron-carbide eutectic, but in relatively small amounts.

Fig. 2 shows the same sample etched and magnified 1,000 diameters. This plate shows in fine detail the structure of the various micrographic constituents, ferrite, pearlite, graphite and eutectic of the iron carbon system sometimes called Ledeburite.

Fig. 3 shows iron No. 2, a Virginia brand, polished and magnified 50 diameters. This sample was taken from a longitudinal section of a sand-cast pig. The short, straight crystals of graphite and the greater predominance of the eutectic constituent is to be noted in contrast with the charcoal iron of Fig. 1, although both the combined and total carbon contents are nearly the same for both irons.

Fig. 4 shows the same iron, with the sample etched and magnified 1,000 diameters. Here we also have in clear detail the constituents ferrite, pearlite, graphite, and, very clearly outlined in the center of the plate, the eutectic.

Fig. 5 presents a still different structure of graphite; a combination of the short, straight crystals and irregular masses and also what may be called the "pine tree" or dendritic crystallites formed during solidification. It is also to be noted that as the percentage of impurities increases the structure becomes more complex. This sample is taken from a cross-section of a machine-cast pig and shows the effects of the rapid cooling of iron cast in this way.

Fig. 6 is the same sample etched and magnified 100 diameters. Here the dendritic structure is shown in a very pronounced form. In the center of the plate some dendritic crystals are shown partially metamorphosed.

Fig. 7 shows a portion of the dendrite of Fig. 6 magnified to 1,000 diameters. Some of the original ribs of the eutectic are shown and also some of the pseudomorphic graphite derived from the decomposition of the cementite.

Fig. 8 shows a sample of iron No. 4 polished and magnified 100 diameters, taken from a machine-cast pig. This iron is made from the same ores as iron No. 3, although the furnaces are not located in the same cities. The analyses are not widely different, yet

the structure is, the graphite being in coarser and more irregular areas.

Fig. 9 is a sample of iron No. 5, magnified 100 diameters. While the silicon content is lower than in the preceding two irons and the total carbon about the same, the structure of the graphite is in the form of large crystals.

Fig. 10 shows the same iron etched and magnified 100 diameters. Here we have a star-like formation of the graphite with pearlite surrounding the same and "Steadite", the phosphide eutectic, in relief.

Fig. 11 is a sample of iron No. 6 polished and magnified 50 times. The phosphorus content being high and the pig. Here the graphite is abundant and coarse, and but little Steadite can be seen in relief.

Fig. 15 shows the same sample as Fig. 14, but etched and magnified to 500 diameters. In the center of the photomicrograph is shown a partially decomposed area of Steadite and bordering it, finely divided graphite, a decomposed product from cementite.

Fig. 16 shows sample of iron No. 8, a high silicon or silvery iron polished and etched, enlarged to 50 diameters. Graphite is abundant, with no evidences of the eutectic constituents. This plate is taken from the edge of a sand-cast pig.

Fig. 17 shows the same iron etched irons, although the percentage of metalloid in No. 10 is larger than in No. 1. This photomicrograph is at a magnification of 50 diameters and was polished without etching.

Fig. 20 is a sample from iron No. 11; the same brand as iron No. 10, although the percentage of silicon is more than 1 per cent lower. This sample is at the same magnification as Fig. 19 and likewise was taken from the edge of the pig.

Figs. 21, 22, 23 and 24 show sections of ½ inch square test bars taken from the four irons used in our foundry. They are known as soft iron, piston ring iron, flywheel iron and cylinder iron, respectively. The photomicro-

Heat Number.	Iron No. 1.	Iron No. 2.	Iron No. 3.	Iron No. 4.	Iron No. 5.	Iron No. 6.	Iron No. 7.	Iron No. 8.	Iron No. 9.	Hard Scrap.	Soft Scrap.	Steel Scrap.	Ferro Manganese, lbs.	Combined Carbon.	Graphitic Carbon.	Manganese.	Phosphorus.	Sulphur.	Silicon.	Nickel.	Chromium.	Shrinkage.	Depth of Chill, ins.	Brinell Hardness.	Tensile Strength, lbs. per sq. in.	Transverse Strength 1-in. bar.	Remarks.
1	33	..	..	..	56	..	..	..	..	..	..	10	..	0.58	2.91	0.61	0.60	0.093	1.83	....	....	0.159 0.163	0.18 0.23	217	29,800	450	Metal in boss of castings spongy. Machine well.
2	23	..	..	..	26	..	..	16	..	..	..	33	3	0.59	2.37	0.80	0.459	0.105	1.90	....	....	0.169 0.164	0.26 0.23	228	32,766	485	Grain of metal very close and fine. Castings all sound.
3	33	..	..	53	..	..	..	5	..	..	..	10	1	0.61	2.88	0.53	0.593	0.096	1.81	....	....	0.164 0.155	0.20 0.19	212	31,583	445	Castings about same as No. 1.
4	33	..	..	56	..	..	..	..	..	..	..	10	2	0.64	2.16	0.47	0.364	0.050	1.94	....	....	.....	.....	....	22,708	....	Castings badly spongy.
5	21	..	..	25	..	..	..	20	..	..	..	33	5	0.62	2.44	0.85	0.504	0.112	1.89	....	....	0.173 0.166	0.50 0.50	235	30,600	460	Grain of metal close. All castings sound.
6	21	..	..	26	..	..	..	18	..	..	..	33	3	0.71	2.00	0.44	0.333	0.115	1.86	....	....	.....	.....	....	36,500	....	Grain not so close as No. 5, but all castings sound. One cylinder misrun.
7	..	..	50	..	..	..	..	16	..	..	..	33	2	0.58	2.44	0.69	0.551	0.100	2.45	....	....	0.168 0.162	0.18 0.16	235	32,400	455	Grain fairly close on 3 castings; 1 spongy.
8	..	..	25	..	..	..	..	18	..	23	..	33	2	0.54	2.41	0.54	0.483	0.121	2.49	....	....	0.169 0.164	0.24 0.19	235	32,400	480	Grain close. All castings sound, but 2 cold shut.
9	..	..	25	..	..	..	..	18	..	23	..	33	3	0.64	1.98	0.54	0.515	0.140	2.00	....	....	.....	.....	....	35,650	....	One casting sound; 2 with small spongy spots; 1 badly spongy
10	25	..	..	..	..	..	..	18	..	..	23	33	3	0.55	2.32	0.53	0.462	0.110	2 48	....	....	0.169 0.164	0.22 0.22	235	.....	450	One casting sound; 2 slightly spongy; 1 badly spongy.
11	25	..	..	..	..	..	..	20	..	..	21	33	3	0.62	2.25	0.62	0.356	0.105	2.78	....	....	.....	.....	....	37,550	....	Grain close and fine. All castings sound.
12	..	..	..	..	28	..	..	16	..	..	21	33	1	0.60	2.42	0.47	0.63	0.115	2.27	....	....	0.168 0.163	0.28 0.30	235	32,733	445	One casting good; 3 spongy.
13	..	25	..	..	..	..	..	16	..	25	..	33	..	0.60	2.22	0.46	0.535	0.111	2.53	....	....	0.168 0.171	0.28 0.29	235	37,760	480	These castings had bad spongy areas; 1 badly spongy.
14	43	..	..	..	..	..	..	23	..	..	..	33	3	0.57	2.47	0.55	0.293	0.105	2.39	....	....	0.165 0.162	0.18 0.10	217	32,000	500	Necessary to enlarge gates to run well; 3 castings misrun. Heat rerun; all castings sound; grain close and fine.
15	..	..	..	..	..	58	..	8	..	..	..	33	..	1.40	2.44	0.23	0.962	0.131	1.99	....	....	0.191 0.180	All chill	255	32,130	385	Castings all good. Grain very light gray.
16	..	..	46	..	..	..	..	3	13	..	36	..	2	0.55	2.98	0.44	0.452	0.087	2.18	0.20	0.46	0.195 0.157	0.09 0.06	205	24,100	455	Grain open. All castings with large spongy spots.
17	30	..	..	..	..	..	..	15	..	..	25	30	..	0.49	2 54	0.62	0.319	0 093	2.12	....	....	0.166 0.166	....	215	.....	450	All castings good; grain close; machine well.
18	30	..	..	..	..	..	..	17	..	..	22	30	3	0.55	2.40	0.69	0.34	0.089	2.29	....	....	0.166 0.160	0.30 0.08	210	.....	450	Grain close; castings good. Machined fair; some hard spots; tendency to chill.
19	30	..	..	..	..	..	..	18	..	..	21	30	3	0.43	2.52	0.63	0.312	0.081	2.23	....	....	0.169 0.160	0.36 0.26	200	.....	480	Grain good; all castings good. Machine poorly; hard spots; tendency to chill.
20	30	..	..	..	..	..	..	30	..	..	..	40	3	0.57	2.44	0.48	0.581	0.100	2.76	....	....	0.154 0.160	0.18 0.26	212	.....	425	Grain good, but metal tough and machines poorly.
21	23	..	..	..	..	..	..	36	..	..	..	40	3	0.46	2.41	0.48	0.651	0.113	2.87	....	....	0.154 0.152	0.22 0.13	207	34.120	445	Grain good; too hard and tough for machining well.

TABLE III—RESULTS OBTAINED FROM VARIOUS MIXTURES OF DIFFERENT GRADES OF PIG IRON

the combined carbon also rather high, we have the "Steadite" constituent to a marked extent.

Fig. 12 shows the same sample magnified 1,000 diameters and etched. Here the detail is shown: Graphite, ferrite, pearlite, and Steadite.

Fig. 13 is a sample of iron No. 7, polished and magnified 50 diameters. This is the same brand as iron No. 3, but sand-cast and taken from the edge of the pig. The slower cooling is evidenced in the coarse graphite crystals.

Fig. 14 is from the same pig as Fig. 13, but the photomicrograph was taken from a sample at the center of and magnified to 1,000 diameters. Here the boundary lines of the crystals of ferrite can be distinctly seen; the center of the ferrite shows a mass of the silico-carbide constituent.

Fig. 18 shows the same iron etched and magnified to 1,000 diameters; the detail of silico-carbide area clearly shown.

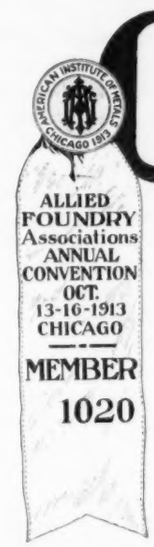
Fig. 19 is taken from a sample of iron No. 10. This plate shows a section taken from the outside of a pig. This is a charcoal brand of iron, but from a section of the country remote from iron No. 1. By referring to Fig. 1 it will be noted that there is a similarity of structure between the two graphs are all at 100 diameters magnification, polished and etched with picric acid. The bars from which these samples were taken were all gated and poured under the same conditions as nearly as possible. Table II gives chemical analyses and physical properties of these irons.

Fig. 25 is taken from a section of a test bar from heat No. 14. The pearlitic structure predominates. This is a good, close grain, tough iron, and all castings poured from it were sound.

Fig. 26 is taken from a section of a test bar from heat No. 15. It shows how, in a high phosphorus iron, the phosphide eutectic tends to segregate.

THE BRASS FOUNDRY

Meeting of the American Institute of Metals



OF FAR reaching importance to the non-ferrous metal industry of the United States and Canada is the work that has been undertaken for the advancement of the trade by the American Institute of Metals and which was comprehensively discussed at the annual meeting of this society held at the LaSalle hotel, Chicago, Oct. 14 to 17. Co-operating with the Bureau of Standards and the Bureau of Mines, this organization is endeavoring to bring about the adoption of a standard test bar for brass foundry use and its report on the results of investigations of furnace practice, which shortly will be available, should be the forerunner of the solution of many melting difficulties. An effort also is being made to standardize the nomenclature of non-ferrous alloys and the report on this subject submitted by C. P. Karr is the most complete that has yet been compiled. A symposium of papers also was presented on scientific management of brass foundry operations and the ensuing discussion indicated that the managers of non-ferrous metal casting shops are increasing the efficiency of their operations on a basis that is mutually satisfactory to both employer and employe.

On Tuesday, Oct. 14, joint sessions were held with the American Foundrymen's Association, but separate meetings were conducted on Wednesday, Thursday and Friday mornings. The attendance was large and reflected a growing interest in the work of this society not only by brass foundry foremen, superintendents and managers, but also by chemists, metallurgists and efficiency engineers. A slight decline in the enrollment which now totals 277, was reported by Secretary W. M. Corse. This is attributed to the fact that no very active campaign was conducted for new members during the year and also to unsettled trade conditions. Secretary Corse briefly outlined the results of the co-operation work with the United States Bureau of Standards and the Bureau of Mines and he ventured the opinion that this will prove more beneficial than almost any line of research that could be undertaken.

The report of Arthur D. Little, Inc., official chemist of the society, largely dealt with the progress that has been made in alloying non-ferrous metals during the year. Some of the new alloys reported upon follow:

An alloy consisting of copper, zinc and tin with a small amount of silicon which is claimed to have excellent strength and elasticity, to be free from shrink-holes in castings, and to be malleable at red heat.

A new white metal alloy, composed of copper, nickel, iron and aluminum, which is unique, as it contains 50 per cent of iron. It is claimed to be non-corrosive and white in color. An alloy for uniting glass, porcelain and stoneware was patented in England, consisting of lead, 10 parts; tin, 5 parts, and bismuth, 3 parts. The alloy is stated to melt at 170 degrees Cent. and is applied in a fluid state.

G. H. CLAMER,
President American Institute of Metals

Dr. Wilhelm Borchers and Otto Barth, of Germany, have patented an alloy of cerium and aluminum, which is claimed to be much more resistant to corrosion than aluminum alone. It has been found in practice that 0.05 per cent of cerium exerts a beneficial effect on aluminum which increases up to a content of 0.2 per cent above which the effect diminishes.

It also was stated that the Society of Automobile Engineers has issued additional specifications for hard bronze, identical to the United States government bronze, *G*, and a specification for gear bronze, similar to that known as English gear bronze. The former specifies a composition of copper, 87 to 88 per cent; tin, 9½ to 10½ per cent; zinc, 1½ to 2½ per cent; and a tensile strength of 35,000 pounds per square inch. The gear bronze specifies an alloy consisting of copper, 88 to 89 per

cent; tin, 11 to 12 per cent and phosphorus, 0.15 to 0.30 per cent.

The co-operative work of the Bureau of Mines with the American Institute of Metals was the subject of a report presented by Charles L. Parsons, chief of the Division of Mineral Technology. At last year's meeting of the institute the main problems of the non-ferrous alloy work of the bureau were outlined as follows:

First.—A comprehensive study was to be made of brass furnaces, with particular reference to fuel efficiency and losses of metal in melting.

Second.—A study was to be made of the precautions to be taken for health and safety in the brass foundry.

Third.—A suitable pyrometer is to be developed for measuring the temperature of molten brass.

Fourth.—An electric furnace suitable for brass melting is to be developed.

It was reported that H. W. Gillett recently has completed a bulletin containing more than 300 sets of data on the performance of 21 distinct types of furnaces in commercial use compiled from information received from 280 firms in 28 states and from visits to 75 foundries and rolling mills in 11 states. The results have been considered with particular reference to the alloys melted, the fuels used, the local conditions affecting the behavior of the furnaces, etc. This bulletin shortly will be available. The subject of health and safety of the workers in brass foundries also has been studied at length and recommendations will be made in this bulletin with reference to the precautions that all foundries should observe.

Considerable work has been done in the development of electric furnaces for brass melting and while one type has been eliminated from consideration for the present, two forms now in use seem to promise satisfactory results. No practical solution of the pyrometer problem has yet been effected, although it is believed that a measuring instrument will be developed during the year.

Pyrometer for Molten Brass

H. W. Gillett, in discussing the pyrometer problem, stated that an instrument should be developed by which the temperature of molten brass can be measured both cheaply and accurately. In reply to numerous questions regarding pyrometers now on the market, he stated that unless the surface of the metal is absolutely clean, varying results will be obtained with a pyrometer of the radiation type. On the other hand, the lag in making temperature measurements with pyrometers of the tube type, as now constructed, to some extent militates against their use. Furthermore the tubes, it was claimed, will break after having been immersed in the metal 10 or 15 times and this necessitates the return of the pyrometer to the maker for repairs. It was estimated that the cost of each temperature reading, even when used 20 times, would be as high as 20 cents and, in addition, it has been found that the readings are not accurate. The question of lag, however, seems to be the chief difficulty at the present time, inasmuch as from two to five minutes frequently elapse before a maximum reading is obtained. In the meantime the metal is cooling and a pyrometer naturally is impractical from that standpoint.

"Internal Strains in Bronze Castings" was the subject of an illustrated address delivered by J. E. Howard, which covered an extensive series of tests made at the Watertown arsenal on rolled brass bars. The strength of the test bars was materially affected by peening and it was believed that the results bear a direct relation to the strains in brass and bronze castings. H. W. Gillett, in discussing these results, stated that while it may be difficult to see a direct connection between peened rolled bars and castings, nevertheless he felt that the results must have a direct bearing on the strains set up in casting. To lessen such strains the patterns should be properly designed and furthermore, annealing may bring about the desired results. Leaving the castings in the molds also will have an annealing effect and will reduce the strains considerably.

The standardization of the nomenclature of non-ferrous alloys was introduced by a brief paper on this subject presented by Dr. G. K. Burgess, of the Bureau of Standards. In view of the rapid development of special alloys, to which are assigned a bewildering chaos of meaningless names, he suggested that some provision should be made for a more orderly naming of non-ferrous alloys. Personal and coined terms have been used extensively in naming particular non-ferrous alloys, but the extent to which this practice should be encouraged in the future, Dr. Burgess said, is a debatable question. Clear-cut definitions of alloys oftentimes will serve as a protection to the seller and will aid the intelligent buyer. It was stated further that there is a gradual tendency toward uniformity in naming as the literature on the subject grows and becomes crystallized. In forming a system of nomenclature, Dr. Burgess added that it would be advantageous to consider the desirability of fixing practical tolerance for some of the more common alloys and perhaps the principles on which such tolerances can be worked out without too great difficulty. As the subject is of such great importance, it was suggested that a joint committee on non-ferrous alloy nomenclature be formed, comprising representatives from the interested societies in the United States, such as the American Institute of Metals, the American Society for Testing Materials, American Chemical Society, American Institute of Mining Engineers and eventually the International Society of Testing Materials, as well as the British metallurgical organizations. C. P. Karr, associate physicist of the Bureau of Standards, presented a comprehensive report on this subject in which he outlined a tentative plan of procedure for the standardization on non-ferrous alloy terms. The report is the most comprehensive that has yet been compiled on this subject and is published elsewhere in this issue.

Discussion of Names

In the ensuing discussion it was stated that it would not be advisable to eliminate the terms manganese bronze and gun metal from a standard non-ferrous alloy nomenclature. The word *brass* to some has a cheap meaning and exception might be taken to the term *iron brass* as designating manganese bronze. It was also stated that it would be advisable to go slow in abandoning some terms. Tobin bronze and Muntz metal have a distinct historical interest. It also was stated that to the secrecy which prevails in the brass foundry trade must be attributed, to a large extent, the chaotic state of nomenclature at the present time. Recently the numerical designation of alloys has grown

G. H. Clamer

G. H. Clamer, who was elected president of the American Institute of Metals, is a metallurgist of wide experience, his investigations of non-ferrous metals and alloys being particularly noteworthy. Born in 1875, he received his education in the public schools of Philadelphia, graduating from one of the manual training high schools in that city. He entered the private laboratory of Prof. F. A. Genth, one of the world's greatest mineral chemists and later entered the University of Pennsylvania as a special student in chemistry, finally working into the regular course and graduating in 1897.

Mr. Clamer started the laboratory of the Ajax Metal Co., Philadelphia, and was one of the first chemists engaged in brass foundry work. He now is first vice president and secretary of that company and is a member of the following organizations: American Chemical Society, Society of Chemical Industry, American Electrochemical Society, American Institute of Metals, American Institute of Mining Engineers, British Iron and Steel Institute, Franklin Institute, American Society for Testing Materials and the International Society for Testing Materials. He is a past president of the Mining and Metallurgical Section of the Franklin Institute and was awarded the Elliott-Cresson gold medal by the latter for processes of refining metals. Mr. Clamer is active in the committee work of the various societies with which he is affiliated and has invented a number of useful alloys and metallurgical processes.

in favor and it was suggested that the Bureau of Standards furnish the institute with a list of numerical alloys, giving also their common names. It was recommended that alloys be classified according to their chemical constituents instead of their physical properties. A resolution was adopted providing for the appointment of an advisory committee to take up the subject of standard nomenclature of alloys with the United States Bureau of Standards with instructions to report at the next annual meeting.

Standard Test Bars

C. P. Karr submitted a report of the work done by the Bureau of Standards on non-ferrous alloys during the last year. At the Buffalo meeting a committee was appointed by the Institute to confer with the Bureau of Standards in reference to the preparation of alloys for standardizing the form and dimensions of test bars. It was decided to confine the work to one alloy at a time, which it was unanimously agreed, should have the following composition: Copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent. The following tests then were decided upon:

First.—To determine the best form of test block and test piece by melting a sufficient quantity of the alloy to permit of casting, from the same crucible, all the various blocks proposed last year. Test bars also are to be cast-to-size, both in green and dry sand, but in accordance with the recommendations of the Society of Automobile Engineers. These test bars are not to be machined.

Two.—After determining the best form of test block and test piece, the alloy is to be cast at various temperatures to determine the best casting temperature.

Third.—The following tests are to be made on all bars: Tensile, elongation, reduction of area, stress-strain curve, compression and microstructure.

Fourth.—After conducting the experiments outlined and when the proper condition under which the metal should be cast to obtain the best results has been ascertained, a sufficient number of test pieces is to be cast to obtain confirmatory results under the following tests: Tensile, elongation, reduction of area, stress-strain curve, heat conductivity, compression, coefficient of expansion, shrinkage, microstructure, tensile properties up to 800 degrees Fahr, hydraulic, corrosion, erosion by steam, sand blast, hardness, electrical conductivity, shearing, specific gravity, impact, fatigue and thermo-analysis.

Equipment for making these tests at the Pittsburgh laboratory of the Bureau of Standards then was described and the method pursued in making the alloy was outlined. A No. 40 crucible was used and when the copper was melted the tin, having previously been warmed, was added and stirred in with a graphite rod, after which the zinc, previously warmed, also was added. The whole mass then was allowed to come to a proper pouring heat and was cast into ingot molds. This method of preparing the alloy was pursued in the first three series of tests. In the fourth series a binary alloy of copper and tin was made and cast into ingot molds and also a binary alloy of copper and zinc was made and likewise cast into ingots. The two binary alloys were then remelted together to form the required ternary alloy. Continuing, the report follows:

For tensile tests four different shaped patterns were used in the first two series of castings. First, a cylindrical bar, 4½ inches long x 2 inches in diameter and a similar bar, only 1 inch in diameter; next a barrel-shaped bar, 4½ inches long x ⅞ inches in diameter at both ends and 1⅛ inches in diameter in the center, and fourth, a cast-to-shape bar, 4½ inches long with a diameter at the ends ¾ inch, reduced in the center to approximately ½ inch diameter. All of these shapes were subsequently turned down in a lathe to the required shape, threaded at the ends, with a diameter of ¾ inch and 10 threads to the inch, and in the center portion worked down to a diameter of 0.505 inch for a distance of 3¼ inches for compression tests; a bar 3½ inches long x 1¼ inches in diameter at the ends, cylindrical in shape, was used first, but later, to facilitate the operations in the lathe, this length was increased to 4½ inches; for hardness tests a flat disc about 2 inches in diameter x ½ inch thick was cast.

The general program called for about 100 specimens in each series; the first series was cast in green sand molds, poured flat with a feeding gate and riser.

The second series also was poured flat, but the molds were skin-dried on the plates of a drying stove. The third series was poured vertically, with the molds skin-dried.

In the third series, the shapes were limited to the 1-inch diameter cylindrical bar and the cast-to-shape bar, with three of each sort in a flask and placed opposite to one another in a series. In all of these castings the runner connecting the pattern with the feeding gate was cut in by a sprue cutter, but later it was thought by the committee that this method of gating introduced a possible variable which might be eliminated by using a pattern gate and runner, which would provide a uniform system of feeding to each shape and also promote a greater uniformity of cooling. In addition to these precautions, the feeding gate was provided with a spherical bulb immediately adjoining the pattern which, when cast, would allow the cooling bar to draw from the reservoir of molten metal thus established, sufficient metal to satisfy all possible demands of the test bar in cooling and thus promote a uniform shrinkage.

The fourth series is now being cast with the new metal patterns, with metal gates molded as described, and is being poured vertically in skin-dried molds, and from the alloy made by the binary method. Additional series are contemplated with the new patterns, the next series to be poured vertically in green sand molds, and two further series to be poured flat, one in green sand and the other in skin-dried molds.

The tests which have been completed in the first and second series, have shown considerable variations in tensile strengths, comparing one flask with another and when poured from the same pot. In the first two series three flasks were poured at even heat. In the third and fourth series four flasks were poured at every heat. The temperatures of pouring have been varied purposely for comparisons, especially in the first two series. In the third series some of the temperatures obtained in the first two series have been duplicated for further comparison and study.

Chemical Analyses and Physical Tests of Bars

No.	Copper, per cent.	Tin, per cent.	Zinc, per cent.	Tensile, strength, lbs. per sq. in.	Elastic, limit, lbs. per sq. in.	Elongation, per cent.	Reduction in area per cent.	Temperature poured, degrees, Cent.	Size of casting, in.
9	87.7	9.8	2.5	17,000	.....	1	..	1,140	2
19	88.0	10.2	1.8	48,050	29,300	26	20	1,155	¾
54	88.0	10.3	1.7	46,450	19,450	20	20	1,165	¾
72	89.1	9.1	1.8	15,600	15,600	4	10	1,050	2
205	89.5	8.5	2.0	21,850	.....	11.5	7.5	1,060	2
213	88.7	9.3	2.0	43,550	19,500	30	30.5	1,060	¾
230	88.2	9.9	1.9	26,750	19,500	8	9	1,150	¾

Effect of Temperature

The comparative effect upon the tensile strengths of pouring the alloy at various temperatures indicated clearly the superiority of the cast-to-shape bars and the sags at the temperatures ranging from 1,140 to 1,150 degrees and also at 1,200 degrees Cent. The variations in comparative strength may be accounted for by the inequalities of the volumes of the various patterns placed in one flask and all poured at one time which would permit of inequalities of pouring, cooling and change in the form and composition of the crystals. Furthermore, some of the variations are due to the differences in the pouring temperatures. Also, the variation in the strength of the different shapes may be attributed to the liquation of the tin,

due to the formation of a solid solution of tin in copper.

To compare the effect of rapid with slow cooling, it has been arranged in the fourth series to pour from every heat a bar cast into an iron chill which will be turned in a lathe to the required shape.

The chemical analyses and physical properties of seven bars are given in the accompanying table. No. 9 was poured flat in green sand at a temperature of 1,140 degrees Cent. The fracture of this metal shows the formation of large crystals. No. 19 was poured flat in green sand at a temperature of 1,150 degrees Cent. The structure is excellent and could hardly be improved. No. 54 was poured flat in green sand at a temperature of 1,165 degrees Cent. The texture of the metal is uniform, the shape of the bar being favorable to rapid cooling. No. 72 was poured flat in a green sand mold at a temperature of 1,050 degrees Cent., which was too low to obtain a solid texture formation as crystallization begins at 1,020 degrees Cent. No. 205 was poured flat in a skin-dried mold at a temperature of 1,060 degrees Cent. The texture of the metal contained a large number of holes, indicating unequal cooling and shrinkage, owing to the unfavorable shape of the bar and slow cooling. No. 213 was poured flat in a skin-dried mold at a temperature of 1,060 degrees Cent. Its shape and dimensions promoted a more rapid cooling than No. 205 and it might have developed better results if it had been poured in green sand. No. 230 was poured flat in a skin-dried mold at the unfavorable temperature of 1,150 degrees Cent. The fractured area contained holes which indicated an unequal rate of cooling, as well as slag enclosures. A supplementary report is to be made embracing all of the work done on the last series of alloys, which will include the summary of all the work done on this alloy together with suggestions that may seem relevant for foundry practice in casting test pieces.

Scientific Management

Practically one entire session was devoted to a discussion of scientific management in brass foundries. The subject was introduced by three papers, namely, "Efficiency Engineering in the Foundry," by E. A. Barnes; "Preparation for Scientific Management," by W. M. Corse, and "How Scientific Management Works in Our Plant," by C. B. Bohn. E. A. Barnes, general superintendent of the Fort Wayne Electric Works of the General Electric Co., said that his idea of attacking the problem of efficiency in the foundry is to develop a man from within the organization rather than to introduce some outsider not familiar with existing conditions. To obtain the best results from the installation of labor-saving devices it is necessary that they be individually adapted to the particular shop in which they are installed. To obtain the best equipment requires special selection and Mr. Barnes said that here is where the efficiency engineer can be of great value, as his undivided attention can be given to comparing the claims made by the various salesmen with the actual results obtained by others who are using the device in question. Such a plan of selection is much safer than that of depending upon the judgment of the purchasing agent, who is influenced in many cases solely by the volubility of the salesman. The choice of molding machines should be considered jointly by the efficiency man and the foundry foreman and other equipment likewise can be selected which greatly will reduce the cost of operations.

Casting Costs

Continuing, Mr. Barnes said that the safety of the molder, including the selection of suitable shoes, gloves, leggings, goggles, etc., and their enforced use, should be solely the work of the efficiency man. On the subject of brass foundry costs Mr. Barnes spoke as follows:

After the efficiency engineer has applied his scientific knowledge and experience in eliminating all lost motion and other wastes in the operating end of the business, his time can be profitably devoted to a study of cost of product. There are at the present time a number of large foundries which are without an exact knowledge of the cost of their product and as a consequence they are satisfied to use in their estimates an average price per pound for castings from each alloy regardless of the shape or weight of the individual patterns. It has been our experience that the costs of brass and aluminum castings on a pound basis show a very wide range of prices when a careful study is given to the segregated labor items such as core work, molding work, etc., and we therefore take every individual form of casting and actually ascertain the cost of material and labor and so charge it. After considerable data on the different classes of work have been accumulated it is not difficult to estimate closely on the new work that comes along. This system of keeping costs involves a little bookkeeping and considerable attention to details, but after the foundry is once placed on this basis and one knows exactly what it costs to produce each casting, the satisfactory returns pay many times for the initial outlay and the periodical checking up that is necessary.

If the highest efficiency in foundry operation is to be attained, a careful consideration of details is required. The manager of the foundry cannot hope to give the time and personal study to the development of new schemes that are required to assure their being practical, and therefore we strongly advocate an efficiency engineer who will have charge of this detail work and be directly responsible to the manager. This efficiency engineer must be a happy mixture of the theoretical and the practical man and for this reason we emphasize our point previously made that he should be a man developed from within the organization.

Labor-Saving Machinery

W. M. Corse, in outlining the preparations for scientific management in the plant of the Lumen Bearing Co., Buffalo, explained that before this plan of operations can be introduced, conditions in the plant itself should be standardized to permit of the proper installation of a wage system. To facilitate efficiency operations there were installed in the plant of the Lumen Bearing Co. molding machines, oil furnace equipment, compressed air, an industrial railway, overhead track, cranes, core room and cleaning room machinery, larger and wider grinding wheels, sand blast, etc. This equipment had the tendency of making a man's job more nearly defined and enabled him to attend to his work without distraction. The net result was a direct increase in the number of pounds of castings produced per man. When this increase was noted it was found advisable to maintain a better record of operations and a defective casting sheet was introduced which showed how many pieces were made each day, how much they weighed, who made them, how many pieces were good, how many pieces were defective and the percentage of losses. The addition of the detailed cost system was next considered and subsequently introduced. The system has been changed considerably from its first form, although the essentials have been maintained. In conclusion Mr. Corse said that one cannot introduce scientific management successful without first modernizing the equipment and process. The work of modernizing the operations of this plant has been spread over a period of four years, but has not yet been completed. Mr. Corse concluded as follows: "I want to array myself on the side of those in favor of scientific management when conservatively introduced into a foundry. I am glad of the opportunity to add my word of testimony regarding the advisability of introducing standard methods and scientific management in a foundry of the jobbing class. The plan, when properly followed, will pay large dividends."

C. B. Bohn, general superintendent of the Aluminum Castings Co., Cleveland, said that four years ago he began a consideration of the subject of scientific management, which was first installed in one of the company's plants at Detroit. A molders' strike necessitated the

formation of an entirely new organization, but in spite of this handicap the installation of this plan of management has proved wonderfully successful. The production has been greatly increased, the quality of castings improved and the cost of manufacture has been considerably reduced. In conclusion he said, "I do not believe that scientific management is a cure-all and I think a great deal depends on the man who installs the system. We are very well satisfied with the work we already have done and feel that we have just started on our campaign for more efficient methods of operation."

Discussion of Efficiency Methods

That this subject is uppermost in the minds of brass foundrymen generally was indicated by the discussion that was precipitated. W. H. Gillett, formerly affiliated with the Aluminum Castings Co., said that one of the first steps leading to an increased output was the introduction of a piece-work basis. Every operation of molding was closely studied and to indicate what can be done along this line he pointed out that the time for making a sprue, for example, was reduced from 25 to 5 seconds. When endeavoring to bring about a change in the wage payment system, he called attention to the fact that it is necessary to let the workmen know that prices will not be cut regardless of the output. W. M. Corse stated that for the line of work made at the plant of the Lumen Bearing Co., the premium basis for a foreman is 15 per cent, which is higher than in a specialty shop and for all defectives below that percentage the bonus increases in a geometrical ratio. A bonus is paid every two weeks for low defectives and also for high production. F. H. Schutz, of the Mueller Mfg. Co., Decatur, Ill., said that when a molder falls below his prescribed output for one week, he gets full pay for his work and this basis of payment continued for a period of three months. It has been found that usually the output will average the prescribed amount in that period. The prices are fixed for a period of one year, never being decreased during that time, but increased if necessary.

In the brass foundry of the National Cash Register Co., Dayton, O., the molders are supposed to earn 50 cents an hour and the price is fixed so that a man can earn this wage. On one job on which the price was fixed to enable the molder to earn $27.50 a week, his output is sufficiently high to net him $50 per week. However, no change in the price has been made. It was the consensus of opinion that the proper mental attitude of the employes toward their employers would greatly facilitate the introduction of scientific management. The necessity of inspection of every molding operation was pointed out. Under scientific management every mold should be inspected before being closed and every core should be inspected before it is placed into the mold. This will result in almost absolutely accurate results. Whenever a new operation is to be performed an inspector in one large brass foundry is called in to watch every movement. Robert Wallace, of the National Cash Register Co., directed attention to the good results obtained from the suggestion system. Prizes are offered for the best suggestions made and adopted and as these are handled by an entirely different department than in the one in which the suggestions originate, the recommended improvement is sent to the head of a department for his adoption.

One foundryman operating a small jobbing shop was of the opinion that scientific management might be satisfactorily adopted in a large plant, but he doubted very much whether it would be possible to install it in a shop employing six or seven molders. It was pointed out that conditions in a small foundry more nearly approach scientific management than in a large shop, due to the fact that the superintendent or foreman usually is familiar with all of the work in hand, knows his men and is in position to direct operations to better advantage than the executive of a large shop who must be dependent, to a large extent, upon assistants. In pointing out the three principles governing the satisfactory application of scientific management in foundries, W. H. Gillett said that the first is *tact*, the second is *tact* and the third is *tact*.

A resolution was adopted providing for the appointment of a committee to consider foundry costs in co-operation with a similar committee appointed by the American Foundrymen's Association. Another committee also will be appointed to discuss with crucible manufacturers the problem of standardizing the size and shape of melting pots.

One of the members asked what should be added to an anti-friction metal mixture to raise its melting temperature 700 degrees. As an experiment a mixture consisting of 80 per cent lead, 15 per cent copper and 5 per cent nickel was tried, but this was found to be unsatisfactory. It was suggested that probably the melting temperature might be increased 700 degrees by the addition of only 1½ per cent nickel in place of 5 per cent nickel, as originally tried. The nickel, it was stated, will prevent the liquation of the lead.

"The Application of Producer Gas to Brass Foundry Work," by E. F. Buhlmahn, discussed the subject of economical fuel with special reference to melting in the brass foundry industry. Since the recent action of the oil companies in withdrawing fuel oil from the market, the procuring of a definite supply of fuel has been given much consideration and in one plant a gas producer has been installed with marked success. By recovering the sensible heat of the waste gases from the furnaces and preheating the incoming gas or air, or both, a high temperature may be obtained with a proportionate high degree of economy. Preheating reduces the cost of installation by reducing the plant capacity due to the decreased cost of consumption and also permits the use of lower pressures of gas and air.

Other papers presented and discussed follow: "The Brass Foundry of the Future," by C. P. Karr; "Core Room Economics," by O. F. Flumerfelt; "The Boiling Points of Metals," by J. W. Richards; "Commercial Operation of the Hering Electric Furnace," by G. H. Clamer; "Silver-plating and Spotting Out," by C. F. Burgess; "Fluxes for Soft Solders," by W. Arthur, and "Approximate Melting Points of Some Commercial Alloys," by A. B. Norton and H. W. Gillett.

Election of Officers

Officers for the ensuing year were elected as follows:

President, G. H. Clamer, Ajax Metal Co., Philadelphia.

Secretary, W. M. Corse, Lumen Bearing Co., Buffalo.

Vice presidents: Rolling mills, W. H. Bassett, American Brass Co., Waterbury, Conn.; Michigan and Ohio, F. O. Clements, National Cash Register Co., Dayton, O.; Ontario and Western Canada, C. H. Ivey, Empire Mfg. Co., London, Ont.; Quebec, Robert Job, Milton-Hersey & Co., Montreal; Pennsylvania, Jesse L. Jones, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; New England, Dr. E. Weintraub, General Electric Co., West Lynn, Mass.; Chicago and Wisconsin, Fred Moerl, Pullman Co., Chicago; Illinois except Chicago, Philip Mueller, H. Mueller Mfg. Co., Decatur, Ill.; New York and New Jersey, C. A. Finnegan, Empire Smelting Co., Depew, N. Y.; Virginia and the South, E. S. Fretz, Light Foundry & Mfg. Co., Pottstown, Pa.

A branch office and warehouse has been established at Galveston, Tex., by the H. W. Johns-Manville Co., New York City, where a complete supply of its products will be carried in stock. This company has two other offices in Texas located, respectively, at Houston and Dallas.

The Nomenclature of the Non-Ferrous Alloys*

A Discussion of the Chaotic State of the Present Terminology

A System is Suggested for Avoiding Further Confusion in Names

By C P Karr†

IN HIS work on "Metallic Alloys", Brannt states that there is such a confusion of terms that many whose interest it is to have an accurate knowledge of alloys do not know what bronze actually is. In corresponding with a large number of firms whose principal business is to produce and sell non-ferrous metals, there is a unanimity of opinion that this confusion of terms is increasing instead of diminishing and some system of classification, that at the same time is simple, scientific and flexible should be undertaken to make it universally acceptable.

Bronze originally was understood to be an alloy formed wholly or chiefly of copper and tin in varying proportions. This enviable prominence, and established tradition produced imitations that were far inferior in physical properties to the original alloys.

Derivation of Term Bronze

The etymological derivation of the term is in some doubt; by some authorities it is supposed to be derived from the same root as the word *brown,* but according to Berthelot it is a place name, coming from *Als Brundisium.* A Greek manuscript of the 11th century contains the name *Brontesion* and gives the composition of the alloy as 1 pound of copper to 2 ounces of tin.

The earliest authentic mention of bronze is made in the fourth chapter of Genesis, period of about 4000 B. C. It is there designated as brass, but it is now believed by authorities that it was an alloy of copper and tin, and not of copper and zinc, as zinc was then an unknown element, but by other authorities, that the word *brass* as used in the Old Testament, referred to the element copper and not to one of its alloys.

Wm. Gowland states that the honor of making the earliest authenticated artistic bronze casting belongs to Egypt; that objects are in existence that were made as early as 3000 B. C.

Bronze poniards, daggers and axes built of bronze and bone, hilts of ivory and horn are shown in the British museum; also in Mr. Greenwell's collection at Durham, Eng., which were found in an Egyptian tomb of the date of 2000 B. C. They contained about 88 parts of copper to 12 parts of tin. The Bronze Age in Europe, by most authorities is fixed at between 2000 to 1800 B. C., but some archeologists have denied that there ever was a distinct bronze age.

What is Brass?

Brass is an alloy consisting mainly, if not exclusively, of copper and zinc. In its earliest use the name was applied to alloys of copper and tin. The brass of the Bible was probably bronze. The Latin word *Aes* was called either pure copper or bronze, not brass. The Romans designated an alloy of copper and zinc as *Orichalcum* or *Aurichalcum,* which Pliny states was made by a union of copper and cadmia (an ore of zinc).

The earliest specimen of brass that has been noted in England was found at Stoke Dabernon, Surrey, which consists of a memorial to Sir John d'Aubernoun, who died in 1277. In England there is evidence of manufacture of brass at the close of the 16th century. Zinc was unknown in Europe until about the 16th century.

The manufacture of brass in Germany was introduced in 1550 by Erasmus Ebener, an artist of Nurnberg, who prepared it by fusing copper with the so-called *tutia fornacem* or furnace cadmia. First made jn England in 1781 by James Emerson, according to one authority, but according to another it is stated that Queen Elizabeth granted a patent to William Humprey to search and mine for calamine for making all sorts of battery wares, cast works and wire of latten, in 1565.

Sheet copper was first made in America, at Canton, Mass., in 1801, by Col. Revere. The first founder who worked in brass in America was Joseph Jenks, who made brass and iron at Lynn, Mass., in 1646. In 1652 silver coins were cast in Massachusetts.

Spelter First Made in 1856

The first refined spelter was made at Bethlehem, Pa., in 1856. The manufacture of gilt buttons was begun in Connecticut by Abel Porter & Co. To obtain brass for this purpose, the mixture was cast into ingots at Waterbury, Conn., where there was an iron mill, driven by water power, in 1802. The first rolling mill built in this country was established at Wolcottville, now Torrington, Conn., in 1834.

In 1808, Pittsburgh contained a brass foundry, a bell maker, five watch and clock makers and a silversmith. Brass gun mountings were made at Philadelphia by Lewis Prahle, in 1776. Brass founding was carried on in Front street, near Market street, Philadelphia, by Joseph Hyatt, in 1723. Among the tradesmen admitted to the freedom of the city of Philadelphia, were James Everett and Simon Edgell, pewterers, Peter Steel and James Winstanly, braziers, in 1717 and 1718.

Origin of Alloys

The first copper rolling mill established in America was built at Soho, N. J., by Hendricks Bros., in 1814, and their mill is still in successful operation. The origin of many other well known alloys is involved in obscurity, especially as to the earliest date of their usage in the arts. It is claimed that Britannia metal was first made in England, by Hancock and Jessop, in 1770, and about the same time German silver was first made in Europe. Pakfong was introduced into Europe from China in the 18th century and was analyzed by Engstrom in 1776. A similar alloy was prepared about the same time from Suhler white copper; the new silver fabrication, however, was begun in 1824 by Henniger in Berlin, and by Geitner in Schneeberg.

German silver originally was made at

*Presented at the Chicago meeting of the American Institute of Metals.

†Associate physicist, Bureau of Standards, Pittsburgh.

Hildberghausen, Germany, but the date of its beginning is involved in uncertainty. It is known that pewter was made in China 2,000 years ago. In France it was made as early as 1229, and in England some time prior to 1290. Pewter was made in America at a very early date. It is uncertain at just what date German silver was made in America, but it is believed by Mr. Sperry to have been begun some time between 1850 and 1860 in the Naugatuck Valley of Connecticut. The Meneeley Bell Foundry was established at West Troy, N. Y., in 1826, but the first church bells were cast at Patuxet river, Rhode Island, by Samuel Walds, in 1735.

Letters were addressed to a number of principal manufacturers of non-ferrous metals, in reference to their practice in naming their various alloys and as to their views concerning the relevancy of the various names used; there was a concensus of opinion that not only was there a confusion of names in vogue, but they also agreed that there was a confusion of ideas as to the correctness of these names as commonly applied. The opinion also was expressed that something should be done to simplify such names to promote a standard of practice. Many of the manufacturers make a great variety of alloys to which they attach numbers for shop identification, but which have no significance to the consumers. Many apply names of their own coinage which serve to connect them only with their own technical use. Many assign trade names which mean nothing to the consumer because their composition is unknown to him, but which facilitate the filling of orders. Some of them define bronze as a copper-alloy with or without lead because of a similar crystal formation in either case. One manufacturer suggested the terms *leaded bronze* and *leaded brass* to distinguish similar alloys that contain no lead. One manufacturer stated that the present nomenclature had grown up to its present state through years of use; he might have added also, through carelessness or abuse or both.

High Brass and Low Brass

Many names like *high brass* and *low brass* have no meaning to the average foundryman, but are applied solely to rolled metals. Some admit that the strength of an alloy has some significance in determining the use of the term *bronze* in engineering practice. It is also alleged that engineers seem to prefer class names, such as *high brass* or *low brass* and to specify the composition of the same. Others agree that a bronze is a two-component alloy and includes the more complete mixtures in which the properties of the alloy are modified by the addition of other elements. One manufacturer states that there is no rational nomenclature in common use. Some call a bronze any copper alloy that in strength, stiffness and color is comparable to the old bronze used for bells, arms, statuary, etc., and that any alloy having copper as a base, but which lacks the strength and stiffness of a true bronze, would not be a bronze no matter what its constituents were.

Confusion of Ideas

To illustrate the confusion of ideas we cite the practice of one manufacturer, who claims that if an alloy has a light yellow color, he would call it brass, no matter what its composition might be; thus an alloy of aluminum 10 per cent and copper 90 per cent, although of a light yellow color, he would call brass, or if it contained 86 per cent copper, 13 per cent tin and 1 per cent aluminum, which is of a light yellow color, he would call it brass, and yet this same manufacturer believes that a rational classification should be made. Another illustration may be cited from another letter of a manufacturer, in which he states that a bronze is an alloy containing nine parts of copper and one part of zinc and that in his foundry practice the alloys of copper and tin that contain less than 10 per cent zinc, carry the general designation of bronze.

One manufacturer states that bronze is supposed to be a mixture of copper, zinc and tin with a sufficient amount of lead for easy machining, and no matter in what proportion this is mixed, it is still termed a bronze, commonly known as low bronze, medium and high bronze. The word *composition* is distinguished from this, in that the latter possesses no tin. Another manufacturer states that composition is an alloy of copper, tin and zinc and may also contain other metals, usually lead.

All agree that in the art of metal founding, there are now used a number of terms that are misnomers, some of which have so good a reason for the names they bear, and have been so long established, that it would be difficult to dislodge them from their present position. Among these misnomers may be placed such alloys as nickel silver, Argentan, white copper, Weisskupfer, new silver, silveroid, silverite, argirode .and the general term German silver, which applies to all of the alloys of this class; they do not contain silver, although they have a silver-like luster and color, and a more appropriate name would be cupro-nickel alloy or composition. One manufacturer would call such an alloy a nickel brass.

Platinoid is an alloy possessing no platinum. It contains 60 per cent copper, 14 per cent nickel, 24 per cent zinc and 2 per cent tungsten, and possesses some of the properties of a platinum alloy. However, it does not contain sufficient tungsten to affect its nomenclature. A cupro-nickel composition would be a better designation. Manganese bronze is really a manganese brass, as it contains no tin and its characteristic properties are conferred by the addition of minute quantities of manganese in the process of melting. A better name for it would be a manganese brass composition and several manufacturers are in accord with this designation.

Aluminum bronze is an alloy of copper and aluminum; the latter metal may amount to as much as 11 per cent and still be a serviceable alloy, but it contains no tin and is, therefore, not a true bronze; this much, however, may be said in extenuation of its name: Aluminum acts as a substitute for tin and imparts to the alloy properties similar to those produced by the presence of tin; also, the term is established by long, consistent usage. Furthermore, no confusion with the true bronzes is likely to arise, because it is an alloy in which tin is seldom used and has distinctive properties of its own. There is some justification in the retention of the name.

Other Confusing Names

Tobin bronze is an alloy of copper, 55.22 per cent; zinc, 39.48 per cent, and tin, 2.30 per cent. This alloy is really a brass composition and a better name for it would be Tobin-brass composition.

Fontaine-Mareau's bronzes contain no tin whatever, and are really white metal alloys. They vary from 91 to 99 per cent zinc, with 8 to 1 per cent copper; one of them contains 90 per cent zinc, 8 per cent copper, 1 per cent iron and 1 per cent lead. The first might be called white metal alloys, the latter, white metal composition.

Morin's imitation Chinese bronze contains 83 per cent copper, 10 per cent lead, 5 per cent tin, and 2 per cent zinc. It is therefore a cupro-lead composition.

The so-called Japanese bronzes, analyzed by Kalischer, contain, copper, 75.53 to 76.64 per cent; lead, 11.88 to 12.2 per cent; zinc, 6.53 to 6.58 per cent; tin, 4.48 to 4.36 per cent, and iron, 0.47 to 0.33 per cent. These are practically cupro-lead compositions. Some Japanese bronzes, analyzed by Maumene, contain from 80.91 to 92.07 per cent copper, 1.04 to 7.55 per cent tin, 1.61 to 0 per cent of antimony, 0 to 5.68 per cent lead, 2.65 to 3.26 per cent zinc, 0.69 to 3.64 per cent iron, 0.4 to 0.10 per cent silicon and 0.21 to 0.56 per cent undetermined matter. All of the latter so-called Japanese bronzes but two might be called cupro-lead compositions, one of the two a bronze composition and the other a cupro-ferrous composition. Not one of them is a true bronze. The so-called Chinese and art bronzes, called

technically *Shakado* and *Shbichi,* are not in any sense bronzes. The first is a cupro-gold alloy and the latter is a cupro-silver alloy; most of the Chinese and Japanese bronzes are cupro-lead composition. Talmi gold contains 86.4 per cent copper and 12.2 per cent zinc. It is merely a brass. Mosaic gold is another alloy of the same type. Birmingham platinum and platinum-lead are distinctly misfits as to names. They contain neither platinum nor lead, but have a variable constituency of copper, zinc and tin. Some of them contain no tin. Without tin they are brasses; with tin they become brass compositions, as the amount of tin employed is very small.

Special Names

There are a number of alloys that are designated by special names, such as Delta, Monel, Speculum, Muntz, Pinchbeck, Tombac, Babbit, Type, Bell, Britania, Pewter and the general family of solders, are all names that offer no conflict with the bronzes, brasses and compositions and, therefore, serve their purpose. There are a number of trade-marked alloys which from the nature of their usage maintain practically a constant composition and do not conflict with the brasses and bronzes. They simply increase the number of names, but add no element of confusion to a rational system of nomenclature.

In order to arrive at a better understanding of the matter and to simplify the suggestions to be offered for a rational classification, it is necessary to furnish a few definitions which will explain the scope of the proposed tentative system of nomenclature.

Bronze may be defined as a two-component alloy consisting of copper and tin in variable proportions, but in which copper is the chief component with a suggested tolerance of 1 per cent of other metals.

Brass may be defined as a two-component alloy, consisting of copper and zinc in variable proportions, but in which copper is the chief component with a suggested tolerance of 1 per cent of other metals.

Composition is an alloy of copper with two or more other metals in variable proportions, but in which copper is the chief component. The chief minor constituent serving to give the titular and qualifying name to the composition. Where two of the metals are of equal percentage in the composition, the element which adds the most valuable property to the alloy will serve to give the combination its qualifying title. Thus, any alloy of 76 per cent copper, 12 per cent tin and 12 per cent zinc might be called a bronze composition; or an alloy of 80 per cent copper, 10 per cent lead and 10 per cent aluminum might be called an aluminum composition. It is certainly neither a bronze nor a brass.

There are a number of terms which make a logical classification difficult, because such names have acquired a certain permanency by reason of established usage, but almost all of them may be assigned to their places in the above tentative scheme, if we accept the suggestion offered by Dr. Rosenhain to the Institute of Metals of Great Britain in January, 1912. If we regard alloys fundamentally as binary alloys, the matter of arrangements is simplified. To make his suggestion adaptable to a large field of alloys, it would be feasible to consider the two chief components of any alloy as a binary unit and consider the other components subservient to them as in reality they would be in the majority of possible combinations. The word *cupro* is distinctive and might be applied where most appropriate, especially where it may seem necessary to be more precise or definite.

Even the much abused term *aluminum-bronze* is a case in point; as used, of course, it is a misnomer, but there could be no confusion in calling any of the aluminum-copper compounds, cupro-aluminum alloys or compositions, it being understood in such a connection that the word *alloy* implies a binary compound, just as we refer to cupro-silicon, cupro-vanadium, cupro-titanium alloys and others. The same suggestion is offered for the binary metalloid combinations such as phosphor-copper, etc. Phosphor-bronze is a term that is an exception to the proposed classification; in this case the minor constituent dominates and establishes the name. A conventional system of numbering, if universally adopted, would be highly advantageous to both consumer and maker, especially in the phosphorous and silicon compounds.

The White Metal Group

In the so-called white metals we have a term that is almost generic in its application and may be made general by bearing in mind certain fundamental distinctions. If we define a white metal alloy as a binary alloy of white metals which are the chief components, to which other metals may be added in variable proportions, we shall produce an alloy whose dominating color is white or nearly so. We may embrace in such a classification almost every known white metal alloy or combination excepting the cupro-nickel alloys, but by our definition they would be excluded because the two chief components of the nickel-silver compositions are not white metals. Generally speaking, a white metal alloy would be a binary combination of two white metals; a white metal composition would be a combination in which tin, zinc, aluminum, lead or antimony, or any two of them is chief component, when three or more elements are united together. In the class of white metal alloys and compositions there may be further subdivisions which are otherwise recognized as Britannia metal, pewters, fusible metals, solders and amalgams.

Britannia metal is an alloy chiefly of tin and antimony with some lead and sometimes minor additions of other metals. Pewter is chiefly an alloy of tin and lead with sometimes added small quantities of other metals. Fusible metals are distinguished from other white metals by their own chief characteristic, namely, fusibility. Soft solders are alloys of tin, lead and other metals. Hard solders are not necessarily white metals and as a rule take the suffix of the alloy to which they are applied, such as brass-solder, aluminum solder, etc. The noble metals follow the same binary arrangement; any two of these metals alloyed together would be called alloys, any three would place them in the composition class, according to their chief minor component. The trade-marked alloys might be maintained as they are now used, provided the names of brass or bronze were not tacked on to them for such procedure would furnish a misleading designation. Special names might be preserved such as Delta metal, Muntz metal, Pinchbeck, etc., so long as no other distinctive metal term is subjoined to give them a spurious significance. Amalgams form a class by themselves and are known to be liquid alloys or plastic combinations of one or more metals with mercury. It would simplify the meaning of such terms if the metal combined with the mercury were to be named first, such as sodium-amalgum, etc., in order to give the consumer a distinct understanding of what he is using.

The tentative scheme of classification suggested may be summarized as follows:

Bronze.—A copper-tin binary alloy with copper as the chief component.

Brass.—A copper-zinc binary alloy with copper as the chief component.

Composition.—An alloy of two or more metals with copper as the chief component.

Subdivision

Bronze composition.—A binary alloy of copper and tin with one or more other variable components, but in which tin is the chief minor component or furnishes the compound with its most important physical property.

Brass composition.—A binary alloy of copper and zinc combined with one or more other variable components, but in which zinc is the chief minor component.

White metal alloys.—A binary combination of any two white metals.

White metal composition.—A binary alloy of two white metals combined with one or more other variable minor components, such as Britannia, pewters, fusible metals and soft solders.

Anti-friction and bearing metals may

be divided into two or three classes, according to their composition. The white bearing or anti-friction metals are all either white metal alloys or compositions; all others are either brasses or bronzes or their corresponding compositions.

Noble metal alloys.—Binary combinations of the noble metals.

Noble metal compositions.—Binary alloys of the noble metals in combination with one or more other noble or base metals as minor components.

Amalgams.—Alloys of mercury with various metals.

Special alloys.—Alloys known by distinctive names, yet by their composition may be placed in one of the above groups.

Trade names.—Alloys whose names are trade-marked, yet may be classified in one of the above groups if their composition be known.

Binary alloys.—Exclusive of bronze and brass, may be placed in a class by themselves, the chief constituent forming the qualifying title, such as cupro-vanadium, cupro-tungsten, etc.

Miscellaneous and misnomers.—All of the so-called nickel silver alloys may be classified as cupro-nickel alloys or compositions according to the number of constituents they possess.

Application of This System

A few examples may be cited to illustrate the application of this tentative classification with some agreements and conflict with present day practice:

Gun bronze, or 90 per cent copper and 10 per cent tin, is a true bronze.

Government metal, or 88 per cent copper, 10 per cent tin and 2 per cent zinc, is a bronze composition.

Muntz metal, or 60 per cent copper and 40 per cent zinc, is a true brass, known by the trade as a yellow brass.

Red metal, or 70 per cent copper, 20 per cent zinc, 6 per cent lead and 4 per cent tin, is a brass composition.

Bell metal, 80 per cent copper and 20 per cent tin, is a true bronze.

Arsenic bronze, or 89.20 to 82.20 per cent copper, 10 per cent tin and 7 per cent lead, with traces or perceptible increments of arsenic, is a bearing metal and might be classed as a bronze composition.

Commercial rod-brass, or 60 to 63 per cent copper, not more than 3 per cent lead and the balance zinc, might be called a brass composition.

Plastic bronze, or copper 69 per cent, tin 10 per cent and lead 21 per cent, is a bearing metal and might be called a lead composition.

Monel metal, or 67 per cent nickel, 27 per cent copper and 6 per cent of other metal, although known to the trade by no other name, might be called a nickel copper composition.

Naval brass, or 59 to 63 per cent copper, 0.5 to 1.5 per cent tin; 0.02 per cent to 1 per cent lead; 0.06 per cent iron and the balance zinc, may be called a brass composition.

Bismuth bronze is a peculiar alloy; it contains 69 per cent copper, 21 per cent zinc, 9 parts of nickel and one part of bismuth alloyed with some tin. It might be considered a low grade of German silver. It is practically a nickel-hardened brass, made to melt at a low temperature. It might be called a cupro-nickel composition.

Mannheim gold is a misnomer. It has practically the same composition as Tombac and Prince's metal, containing 89.44 per cent copper and 9.14 per cent zinc, according to one authority, while another states it is 75 per cent copper and 25 per cent zinc or 80 per cent copper and 20 per cent zinc. All agree, however, that it is strictly a true brass and nothing more.

Manganese bronze, so-called, is composed of 57 to 60 per cent copper, 0.5 per cent tin, 37 to 40 per cent zinc, iron not to exceed 1 per cent and 0.3 per cent manganese, and sometimes contains aluminum. It is plainly to be seen that this is a manganese brass composition.

Phosphor bronze is an alloy of copper and tin with generally less than 1 per cent of phosphorus. There is no serious objection to this name.

Aluminum bronze is an alloy of copper and aluminum in variable proportions; while it has many admirable properties, it is begging the question to call it bronze. If the trade would accept conventional numbers for the 5 and 10 per cent aluminum constituent as Nos. 1 and 2, respectively, it might soon become known to all consumers as No. 1 and No. 2 cupro-aluminum alloys.

Distinctive Names of Alloys

Many alloys bear distinctive names, but their classification offers no difficulties nor conflicts.

Onion's alloy is a fusible metal, composed of lead, three parts; tin, two parts, and bismuth, five parts. It melts at 197 degrees Fahr.

Queen's metal contains 76 per cent tin, 8 per cent bismuth and 8 per cent lead. It is a pewter, otherwise a white metal composition.

Mackenzie's alloy contains antimony 16 per cent, bismuth 16 per cent, lead 68 per cent, or antimony 17 per cent, tin 13 per cent and lead 70 per cent. It is a good stereotype metal otherwise, a white metal composition.

Kingston's metal contains 9 parts copper to 24 parts tin, remelted and added to 108 parts tin, and 9 parts of mercury; it is a white metal composition.

Platine is composed of 43 per cent copper and 57 per cent zinc, and is a white metal alloy. Many other special names might be added to the list, but all of them are capable of classification as suggested.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Gun Metal Mixture

Kindly furnish us with a good mixture for making gun metal.

We suggest the use of the following mixture: Copper, 88 pounds; tin, 10 pounds, and zinc, 2 pounds. To obtain the best results, this alloy should be made with great care to prevent the undue oxidation of the copper. A thick cover of charcoal should be maintained on the copper and when charging the crucible, care should be exercised to prevent the copper from projecting above the top of the pot.

Cheap Red Brass

Kindly furnish us with a cheap red brass mixture which will be easily machinable and will be sufficiently dense to withstand an ordinary oil pressure.

The following alloy should prove satisfactory for this purpose: Copper, 85 pounds; zinc, 8½ pounds; tin, 3½ pounds, and lead, 3 pounds.

Vanadium Bronze

Kindly furnish a mixture for vanadium bronze and outline the method of melting and casting.

Vanadium can be added in the form of vanadium-copper to any alloy of copper and the resulting alloy will be termed vanadium bronze. An alloy containing 88 per cent copper, 10 per cent tin and 2 per cent of zinc, can be treated with 0.25 to 1.00 per cent vanadium-copper and then will be known as vanadium bronze. Similarly, a manganese

bronze when treated with vanadium can be termed vanadium bronze and, therefore, it is apparent that this term covers a wide range of mixtures containing vanadium. Vanadium is used in nonferrous alloys as a deoxidizer. We would suggest that you experiment with vanadium until you find a mixture that is adapted to your purpose.

Sweating of Metal Patterns

Notwithstanding the many precautions we take, the aluminum patterns which we use sweat in damp weather. The plates contain 80 per cent of aluminum. Can you suggest any remedy?

The sweating of aluminum pattern plates is due to the condensation of atmospheric moisture, which can be prevented by keeping the plates warmer than the surrounding air. During the winter months, when the sand is cold almost to the point of freezing, the temperature of the patterns that come in contact therewith is much lower than that of the air of the shop and if the latter is saturated with moisture, it will be precipitated upon the pattern plates. As long as this condition prevails, nothing can be done to prevent the plates from sweating. The composition of the metal composing the plates in no way affects sweating, as any other metal will sweat in the same way as the 80 per cent aluminum alloy referred to.

Crystallization of Zinc

We are experiencing considerable difficulty in casting hollow rolls, 1½ to 2 inches metal thickness. The trouble is caused by the crystallization of the zinc at the bottom of the mold. We are using a standard No. 12 aluminum of the following mixture: Aluminum, 70 parts; zinc, 27 parts, and copper, 3 parts. The metal in the cope is sound, the crystallization occurring in the drag only. By reheating the metal several times the crystallization disappears, but the metal assumes a much darker color. On small, light castings this difficulty is not experienced and the crystallization occurs only on heavy castings. We would like to retain this mixture and will be pleased to have you advise us how to overcome this crystallization.

It is doubtful whether the difficulty outlined can be overcome except by changing the mixture to one containing a small percentage of zinc. The use of chills at the bottom of the mold might be tried, as there is a possibility that by quickly solidifying the alloy, crystallization might be prevented. The reason that this difficulty is not experienced when making light castings is that the alloy solidifies before the zinc has an opportunity to segregate. When making heavier castings, however, the rich aluminum-zinc alloy settles to the bottom and solidifies in the form of large crystals. If you have a large number of these rolls to make, it might be advisable to experiment with a metal mold, preferably made of copper, to form the outside of the casting, while the inside should be cored. The addition of magnesium might correct the difficulty, but at the same time it would increase the cost. Calcium also would prevent the crystallization of the zinc, but it would involve another difficulty, namely, the decomposition of water when the alloy is hot. Consequently, it would attack the moisture in the sand with the result that the outside of the casting would practically be decomposed. Therefore, it seems that the only alternative is to change the alloy and we recommend one containing 2.5 per cent copper and 19 per cent zinc and if the same trouble is experienced, use an alloy containing 4 per cent copper and 15 per cent zinc.

Manganese-Copper Replacing Phosphor-Copper?

We are investigating the use of manganese-copper as a flux to replace phosphor-copper, and also, we would be pleased to have you inform us whether this is the general tendency in brass foundries throughout the country.

Our available information indicates that there is no tendency to supplant phosphor-copper by manganese-copper and we fail to see what advantage would be obtained by doing this. Manganese cannot be used with the same freedom as phosphorus without producing casting difficulties, such as cold shuts, etc. In making yellow alloys, manganese is to be preferred to phosphorus, but it must be used in homeopathic doses. In bronze and red brass, manganese should be used in conjunction with phosphorus.

Cost of Phosphor-Bronze Locomotive Bearings

With phosphor-bronze made from 80 per cent copper, 10 per cent tin, 9 per cent lead and 1 per cent phosphorous, as a basis, what would be the cost per pound of locomotive bearing castings and miscellaneous locomotive work? What would be the cost of the fuel per pound and at what price per ton do you figure coal or coke? What would be the cost per pound of cleaning and handling this material? What is the proper allowance for power, sand, furnace repairs, etc.? In brass foundry practice, what is considered the standard loss? What percentage of the total weight of these castings would have to be remelted in the form of gates, etc.?

An excellent method of estimating the selling cost of castings was described by W. M. Corse, secretary of the American Institute of Metals, in an article published in THE FOUNDRY, April, 1913, page 162. In estimating the cost of castings such as are used on locomotives, the proportion of castings per 100 pounds of metal melted will be considerably higher than the 45 per cent noted in this article, because this class of work is heavier than the usual run of castings in ordinary brass foundry practice and the proportion of gates, etc., to castings is less. For driving brasses, rod brasses, gibs, tender brasses, etc., the proportion of gates and spilled metal should be less than 25 per cent per 100 pounds of metal melted. A comparatively small number of light castings enters into locomotive work and many of these are turned out of solid bars. Consequently, the average proportion of castings per 100 pounds of metal is higher than the percentage given, but the class of labor employed as molders should be considered. If the labor is not high grade, the proportion of defective castings will be excessive and it may be possible that the proportion of good castings will fall considerably below 45 per cent of the amount of metal melted.

Regarding the cost of fuel, this may range, in a case of anthracite coal, from 1 pound of fuel to 1 pound of metal to 1 pound of coal and 3 pounds of metal, according to the weight of castings and the furnace practice. Approximately 1¼ to 1-1/3 pounds of coke will be required per pound of small castings shipped and for large castings about 1½ pounds of coke per pound of metal. An average oil consumption of 3 gallons per 100 pounds of metal melted is considered good practice. The cost per pound for cleaning and handling will depend upon the equipment and the cost of labor. No arbitrary allowance can be made for power, sand, furnace repairs, etc., as the cost of these items depends entirely upon the skill of the management.

Aluminum Difficulties

Is there any difference in the shrinkage of such castings as door knobs, when molded loose or molded by match plates? The alloys used are aluminum and nickel and aluminum and copper. What flux should be used?

We fail to see in what way the method of molding would effect the shrinkage, as any metal will have the same contraction regardless of whether cast in sand or permanent molds. In the case of aluminum, hard cores, which will prevent free shrinkage, produces a rupture of the casting in place of retarding the shrinkage. The copper-hardened aluminum alloy will prove the most satisfactory of the two mentioned. The best flux for aluminum is zinc chloride.

Great Foundry Equipment Exhibition at Chicago

A Summary of the World's Largest Industrial Show Epitomizing the Year's Progress by Manufacturers of Foundry and Shop Machinery

CONCURRENT with the annual meetings of the American Foundrymen's Association, American Institute of Metals and the Associated Foundry Foremen, which convened at the LaSalle hotel, Chicago, Tuesday, Oct. 14, was held an exhibition of foundry supplies and equipment, machine tools, etc., at the International Amphitheater, Forty-third and Halsted streets, that surpassed both in number of individual displays and floor area occupied, any similar show previously conducted in this country. In addition to the main area of this spacious exhibition building, four structures were crowded with foundry, machine and pattern shop machinery and with few exceptions this equipment was in operation.

The exhibition, which was opened on Friday morning, Oct. 10, was conducted under the auspices of the Foundry & Machine Exhibition Co. The floor area occupied by the 169 individual displays aggregated nearly 65,000 square feet and the value of the equipment was estimated approximately at several million dollars.

The attendance greatly exceeded expectations and the business transacted by the companies represented was exceedingly gratifying. The shows was continued until Friday night, Oct. 17. The molding machine display was unusually large, both in the number of individual exhibits and diversity of machines shown. While the equipment embodied no radical principles of operation, nevertheless numerous new combination machines were introduced. In the design of tools of this type, the tendency is toward the mechanical performance of every movement involved in making a mold and the elimination of hand work entirely. Three different types of electrically-operated, jar-ramming machines were shown as compared with only one last year. The economy, ease of application and flexibility of electric power is only beginning to be recognized by molding machine manufacturers and foundrymen generally, and its use in casting plants promises to be extended rapidly. Many of the machines exhibited were improved, if not redesigned, since the Buffalo show last year and this reflects the wonderful enterprise of builders of this class of machinery and their desire to meet every requirement of the casting manufacturer.

An exceedingly ingenious combination machine was exhibited by the Midland Machine Co., Detroit. Operated by compressed air, it rammed the mold by jarring, clamped it automatically by two arms and rolled it over in position for drawing the pattern. The jar-ramming table then was elevated by the piston of the jar-ramming cylinder until it came in contact with the bottom board of the mold, the vibrator set in motion and the pattern was mechanically drawn from the mold. After lifting off the mold, the roll-over mechanism was rolled back into its original position, the pattern plate was lowered onto the jar-ramming table and a flask was set in position for making another mold. One feature of the machine that proved interesting to the visiting foundrymen was the provision for drawing the pattern at any desired speed. All of the operations are controlled by three levers and are performed by a double acting cylinder.

ONE SECTION OF THE EXHIBIT IN THE ARENA OF THE AMPHITHEATER, SHOWING A PYRAMID OF JAR-RAMMING MOLDING MACHINES

Another combination machine, exceedingly simple in design and construction, was shown by the Federal Foundry Supply Co., Cleveland. This was the jolt-roll over and direct-draw type. The roll-over device to which the pattern or core box was bolted was hinged to the jolt-ramming table and after making the mold it was rolled over by hand. After leveling the bottom board, the pattern was drawn by raising the jar-ramming piston which elevated the table to which the roll-over device was hinged. By withdrawing the hinge pin of the roll-over mechanism, the latter can be detached from the machine and the device can be converted into a plain jar-rammer. Other machines exhibited included several types of plain jar-rammers for making molds and cores. A total of 19 machine was included in the exhibit made by the Osborn

GENERAL VIEW OF THE EXHIBIT IN THE MAIN ARENA

Mfg. Co., Cleveland. Several new types were shown, a 54-inch, jolt-ramming, direct-draw, roll-over machine having attracted considerable attention. Two other sizes of this type, namely 22 and 30-inch, also were displayed, which demonstrated both the roll-over and stripping plate principle. A hand roll-over machine, ingeniously equipped with match-plates for making molds for a heater fire pot, shaker grates and a stove top shelf, eliminated several operations heretofore separately performed and effected great economies in molding costs. Among the other new machines were included a small foot power jar, direct-draw and roll-over machine and a portable pneumatic squeezer equipped with ball-bearing wheels, described in the October issue of THE FOUNDRY. A device which will save considerable time in the operation of jar-ramming, roll-over molding machines, also displayed by the Osborn company, consisted of a pneumatic lock for clamping bottom boards to the table of machines of this type.

Since the Buffalo show, the jar-ramming, roll-over, squeezer and pattern-drawing machines built by the A. Buch's Sons Co., Elizabethtown, Pa., were greatly improved and two types were displayed, for either hand or power operation. In addition, the line of aluminum snap flasks made by this company were exhibited as well as cast iron jackets. The gravity molding machine built by the Buch's company was not exhibited although it has been practically remodeled and greatly improved during the last 12 months.

Electrically Operated Machines

The new combination of electrically-driven, jar-ramming molding machines first introduced by Henry E. Pridmore, Chicago, last year, were displayed. These included an electrically-driven jar-ramming, rock-over machine and an electrically-driven, jar-ramming stripping plate machine. On the stripping plate machine, a large tee pattern was mounted and an engine base was mounted on the electric driven jar-ramming rock-over. New plain 10-inch power squeezers and stripping plate power squeezers also were exhibited. Various types of the extensive line of machines built by Henry E. Pridmore were shown, totaling 20 models.

A feature of the exhibit made by the Arcade Mfg. Co., Freeport, Ill., was a pyramid of ten Norcross jar-ramming machines which had a combined jolting capacity of 291,000 pounds and a total weight of 121,590 pounds. The base of the pyramid consisted of a large, three-cylinder machine, equipped with a 7 x 14-foot table and with a capacity for ramming molds weighing 90,000 pounds. The next machine was of the two-cylinder type, with a table 6 x 10 feet and a jolting capacity of 43,000 pounds. The remainder of the pyramid, which had a height of 38 feet, was built-up of single cylinder machines as follows, in the order of their capacities: 25,000 pounds, 16,000 pounds, 18,000 pounds, 16,000 pounds, 4,000 pounds and 1,500 pounds. The top of the pyramid consisted of small jolt rammers of the single cylinder type adapted to coremaking. A Modern machine, built by the Arcade company, equipped for squeezing the mold, drawing the pattern and moving the mold forward for lifting off by compressed air, also was shown.

ANOTHER VIEW OF THE EXHIBIT IN THE MAIN ARENA

Plain and combination electrically-operated molding machines were among the new types introduced by the International Molding Machine Co., Chicago. The combination machine was of the jar-ramming turn-over type with a capacity for making half molds weighing 500 pounds. The motor for driving the machine had a capacity of only one horsepower. Another interesting machine was an air squeezer equipped to ram copes and drags at different pressures.

Several new types of Dearsley mold-

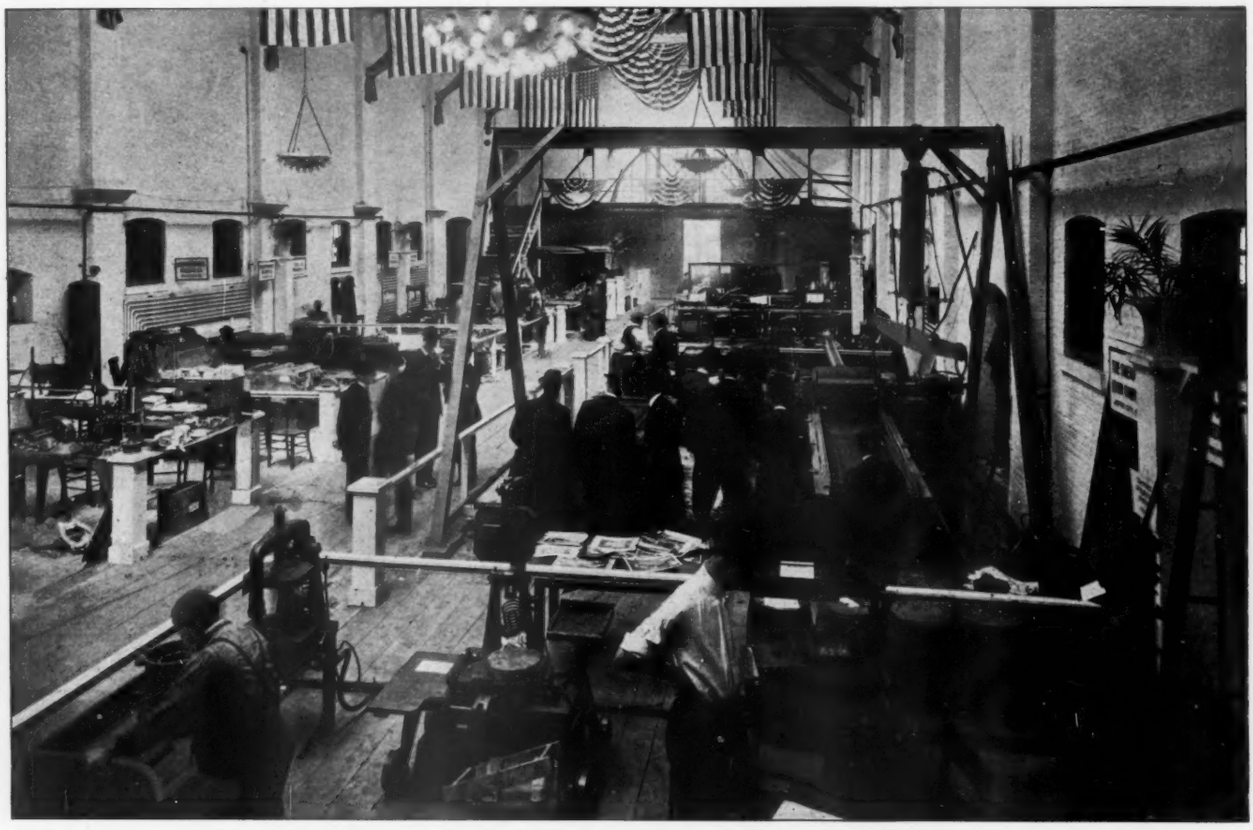
ing machines were shown by the S. Freeman & Sons Mfg. Co., Racine, Wis. One consisted of a hand-operated stripping plate molding machine. The roll-over mechanism was counterbalanced so as to facilitate this operation with the least amount of effort on the part of the operator. An interesting feature of this exhibit was a stripping plate machine capable of handling four-part molds. The two cheek plates were attached to the machine and were arranged for stripping, while the cope and drag plates were hinged, having been swung forward into molding position after the two cheeks were stripped. In addition, this machine made the green sand cores required for the mold demonstrated.

A sectional operating model of the jar-ramming machine, built by the Mumford Molding Machine Co., of which the Vulcan Engineering Sales Co., Chicago, is exclusive sales agent in the west, attracted a large amount of attention. A 14-inch jolt ramming machine also was shown which was equipped with a 48 x 72-inch table and a pit pattern draft device. Although one of the pioneer builders of pneumatic jar-ramming machines, the Mumford company now is manufacturing an electrically-operated jarring machine, one size of which was shown in operation. Other novel machines included a hand-operated 3-inch jolt rammer equipped with a stripping plate mechanism and an 8 x 8-inch baby jolt ramming core machine with a lifting capacity of 90 pounds. This machine is hand-operated and is adapted to core shop use, particularly for rapidly ramming small shapes.

Roller-Ramming Machine

The roller-ramming machine, built by the Snead & Co. Iron Works, Jersey City, N. J., which was shown in operation, was equipped with a pattern for a gray iron book case casting, 7 feet, 6 inches long and 25½ inches wide. In the operation of this machine, a cast iron roller is employed for ramming the sand. After sand has been riddled over the pattern, the flask is filled by a sand-dumping box which is moved into position above the machine by an air hoist operating over an I-beam spanning the machine. After the roller has passed over the sand several times, the sand is struck-off by hand, the pattern is lowered away from the mold which is lifted off by the same hoist that conveys the dumping box to the machine. Other patterns used for demonstrating purposes included plates containing eight radiators and three pieces of stove plate, including a stove top, stove side and stove door. One of these machines, recently installed, is used for molding textile machinery castings, 15 feet long and 30 inches wide. The roller is operated by a 3-horsepower motor.

Several new combination machines were exhibited by the Herman Pneumatic Machine Co., Zelienople, Pa. The independent jar-ramming, independent roll-over and independent pattern-drawing machine proved a novelty, inasmuch as each operation is performed by a separate air cylinder. For light work, a jar-ramming, squeezing and hand-stripping plate machine was introduced. Another new machine for making molds and cores was of the jar-ramming, hand-draw type, equipped with a combination roll-over and stripping plate device.



A SECTION OF THE MOLDING MACHINE EXHIBIT

A new power squeezer was displayed by the Berkshire Mfg. Co., Cleveland. the squeezer head being adjusted by a screw. A combination air squeezer, for either hand or power operation, and a core machine, the latter having been practically re-designed, also were shown.

Among the new machines shown by the Davenport Machine & Foundry Co., Davenport, Ia., was a power squeezer and other types included portable and stationary jolt rock-over machines, plain jolt machines and

hand-ramming, roll-over machines. With the manufacturers of pneumatic tools striving to reduce the air consumption of their devices and the builders of compressors constantly working toward increased efficiency, the advantages of compressed air are daily becoming more apparent to the foundryman. The exhibition at the International Amphitheater included liberal displays of pneumatic hammers, rammers, drills, etc., air hoists, trolleys and cranes together with compressors of all kinds. During the past year special attention has been given to the development of small compressors that will operate efficiently and sufficient progress has been made so that now even the smallest foundry need not forego the conveniences of compressed air.

Among the exhibitors of pneumatic machinery were the Chicago Pneumatic Tool Co., Chicago; Cleveland Pneumatic Tool Co., Cleveland; Curtis Pneumatic Machinery Co., St. Louis; Independent Pneumatic Tool Co., Chicago; Ingersoll-Rand Co., New York; Sullivan Machinery Co., Chicago; the Gardner Governor Co., Quincy, Ill., and the American Steam Pump Co., Battle Creek, Mich.

Although the exhibits of sand-handling machinery contained nothing revolutionary in design, numerous minor improvements and refinements were embodied in the apparatus on display. In the construction of batch mixers, rotary sifters and vibrating riddles of various types there is a pronounced tendency to use heavier materials and more rugged fastenings in order to avoid breakdowns and insure long life under severe operating conditions. Some manufacturers are substituting steel castings for gray iron wherever possible. Several types of single line grab buckets designed primarily for handling sand and cleaning floors in steel foundries were shown. There has been no change in the essential features of these buckets since they were first introduced three years ago; the improvements embodied in the latest buckets include refinements in details, the employment of heavier plates and steel castings and changes in the shape of the bucket which permit it to work up into corners and prevent sand from sticking to the inside of the shell when open. One manufacturer showed a motor-driven, self-propelled sand-cutting and mixing machine of novel design.

Among the exhibitors of sand-handling machinery were the Arcade Mfg. Co., Freeport, Ill.; Battle Creek Sand Sifter Co., Battle Creek, Mich.; Blystone Machinery Co., Cambridge Springs, Pa.; Chicago Pneumatic Tool Co., Chicago; Duplex Shaker Works, Chicago; Great Western Mfg. Co., Leavenworth, Kan.; J. S. McCormick Co., Pittsburgh; William Sellers & Co., Philadelphia; Standard Sand & Machine Co., Cleveland; Sand Mixing Machine Co., New York; The Hayward Co., New York, and Pawling & Harnischfeger Co., Milwaukee.

The growing importance of sand-blasting as an economical method of cleaning castings was demonstrated by eight large working exhibits. Economy in the use of compressed air is receiving increasing attention on the part of the builders of sand blast apparatus and the latest machines with improved nozzles use only about one-half the air required for the earlier devices; special attention is also being given to apparatus for reclaiming the used sand. In the larger machines this is usually accomplished by providing a hopper under the work grating into which the sand falls and from which it is transferred to the supply hopper by a bucket elevator. In the past year the development of semi-automatic sand blast machines has gone forward apace; these include sand blast barrels with fixed and oscillating nozzles, continuous machines in which the work is placed on a moving platform or a rotating table. In some machines, chilled steel shot is

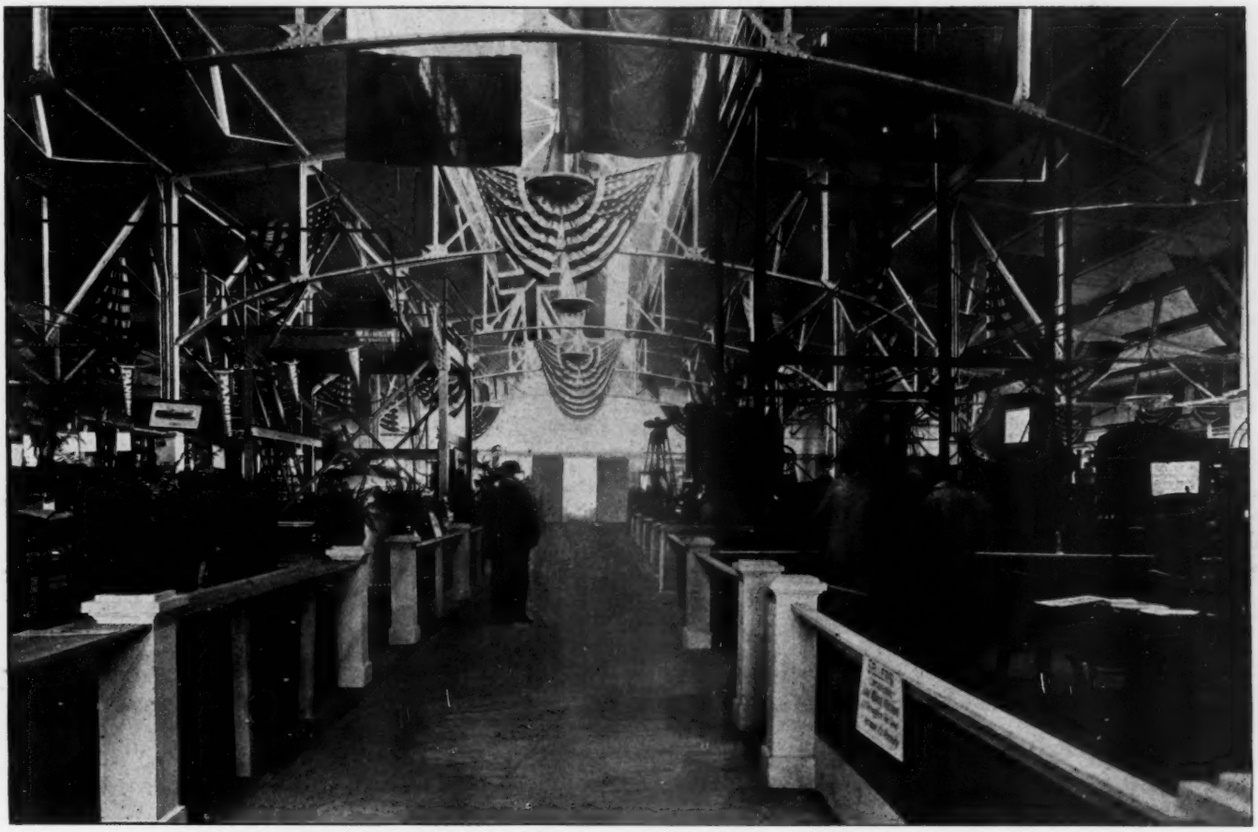


EXHIBIT OF SAND-HANDLING EQUIPMENT, SAND BLAST MACHINES, ETC.

used to good advantage in place of sand. The Hoevel Sandblast Machine Co., New York, exhibited a continuous machine provided with a horizontal rotating table. This machine is especially suited to foundries turning out a large number of light castings. The New Haven Sand Blast Co., New Haven, Conn., displayed a self-contained sand blast barrel; in this device the sand mixer is contained in the barrel and there is no rubber sand hose. A high pressure machine using 69 cubic feet of free air per minute at 80 pounds pressure was exhibited by the Carter Metals Cleaning Co., Philadelphia. The Mott Sand Blast Mfg. Co., affiliated with the De La Vergne Machine Co., New York, exhibited a sand blast barrel with an oscillating nozzle and also displayed an all-steel sand blast room with special dust collecting facilities. The Pangborn Corporation, Hagerstown Md., displayed a hose type, semi-automatic sand blast and a double-nozzle sand blast barrel provided with special devices to economize air. The W. W. Sly Mfg. Co., Cleveland, showed an automatic machine which includes a sand blast barrel, sand sifter, elevator and storage hopper. Other standard sand blasting equipment was exhibited by the J. W. Paxson Co., Philadelphia, and the Macleod Co., Cincinnati. W. F. Stodder, Syracuse, N. Y., exhibited a sand blast nozzle which can be operated without a special tank for the sand. Chilled shot or iron sand for use in sand blast machines in place of sand was shown by the Globe Steel Co., Mansfield, O.

Match Plates

The economies possible through the use of aluminum match-plates were amply demonstrated during the show. One exhibit included match-plates in various stages of manufacture and a complete kitchen range cast from match-plates illustrating the thin sections and clean cut castings made possible by the employment of this method of molding. Another exhibitor had the plates fitted to molding machines and demonstrated them in actual use while a third displayed a special, non-shrinking, white match-plate composition.

The exhibitors of match-plates included the Goodale Co., Kalamazoo, Mich., the Arcade Mfg. Co., Freeport, Ill., and the Federal Foundry Supply Co., Cleveland.

In the three exhibits of oxy-acetylene welding apparatus the standard types of generating machinery, torches, tables and auxiliary paraphernalia were displayed. Demonstrations of welding and cutting were given throughout the week. One manufacturer has developed a light torch specially designed for soldering and brazing; another has developed a pantograph device for accurate cutting with the oxy-acetylene torch.

The exhibitors of welding devices included the Oxweld Acetylene Co., Chicago; the Prestolite Co., Indianapolis, and the Davis-Bournonville Co., New York.

The Foundry Equipment exhibits were unusually complete and included displays of tumbling barrels by the W. W. Sly Mfg. Co., Cleveland; Whiting Foundry Co., Harvey, Ill.; S. Obermayer Co., Chicago, and the Calumet Foundry Equipment Co., Harvey, Ill.

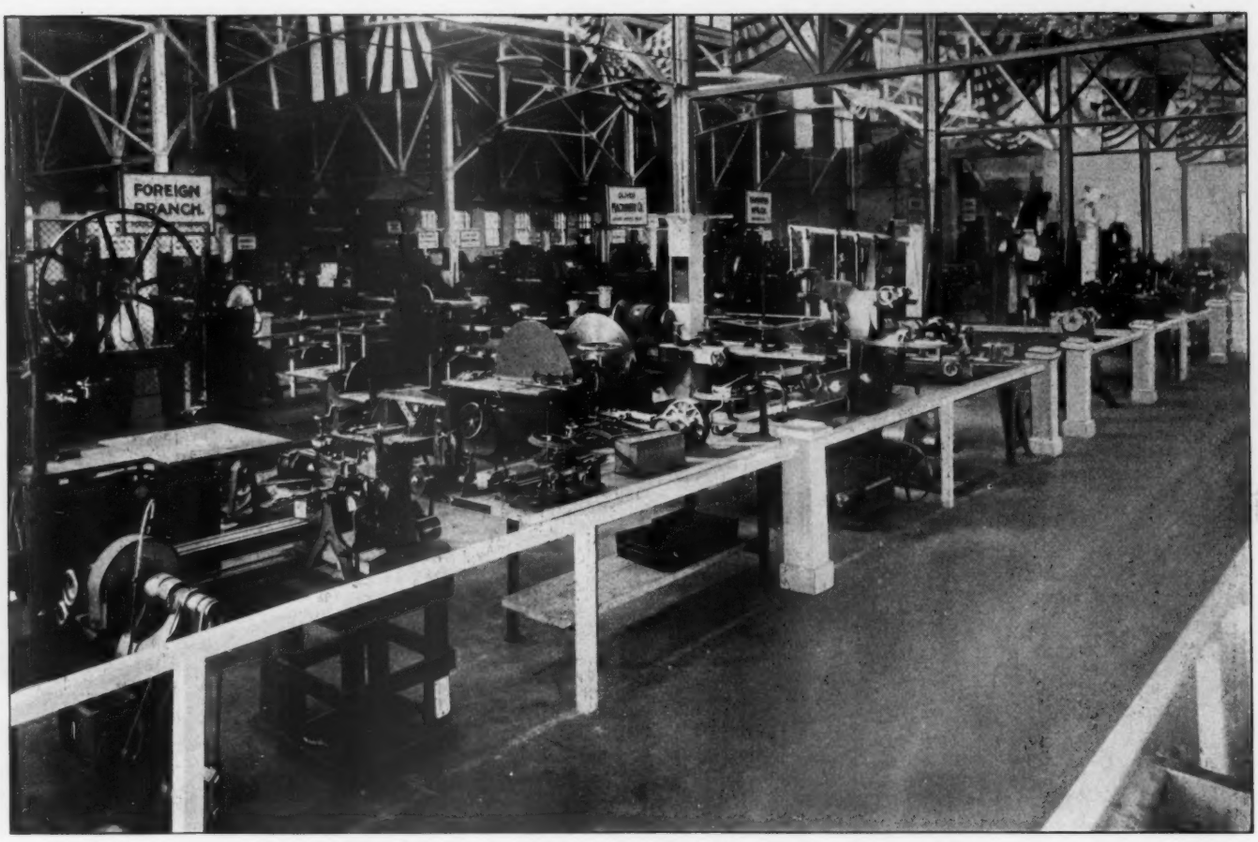


EXHIBIT OF MACHINE TOOLS, SHOWING PATTERN SHOP EQUIPMENT IN THE FOREGROUND

Blast meters for cupolas, Chas. J. Clark, Chicago; steel shop furniture including barrels, boxes, pattern racks, etc., Cleveland Wire Spring Co., Cleveland; motor and turbine-driven air compressors, General Electric Co., Schenectady, N. Y.; core ovens, Quigley Furnace Co., Springfield, Mass., Monarch Engineering & Mfg. Co., Baltimore and Whiting Foundry Equipment Co., Harvey, Ill.; casting machines equipped with permanent molds, Quitman Foundry & Machine Co., Quitman, Ga.; automatic plate and pipe polishing machines, the W. V. Robinson Co., Owosso, Mich; cranes and hoists, Vulcan Engineering Sales

Co., Chicago, Whiting Foundry Equipment Co., Harvey, Ill., Wright Mfg. Co., Lisbon, O., and the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.; steel flasks, jackets, etc., Sterling Wheelbarrow Co., Milwaukee; electrical equipment for foundries, Westinghouse Electric Mfg. Co., Pittsburgh; wire guards for lighting fixtures, sockets, clusters and other lighting specialties, Benjamin Electric Mfg. Co., Chicago; pumps, American Steam Pump Co., Battle Creek, Mich., and dust collectors, the Knickerbocker Co., Jackson, Mich.

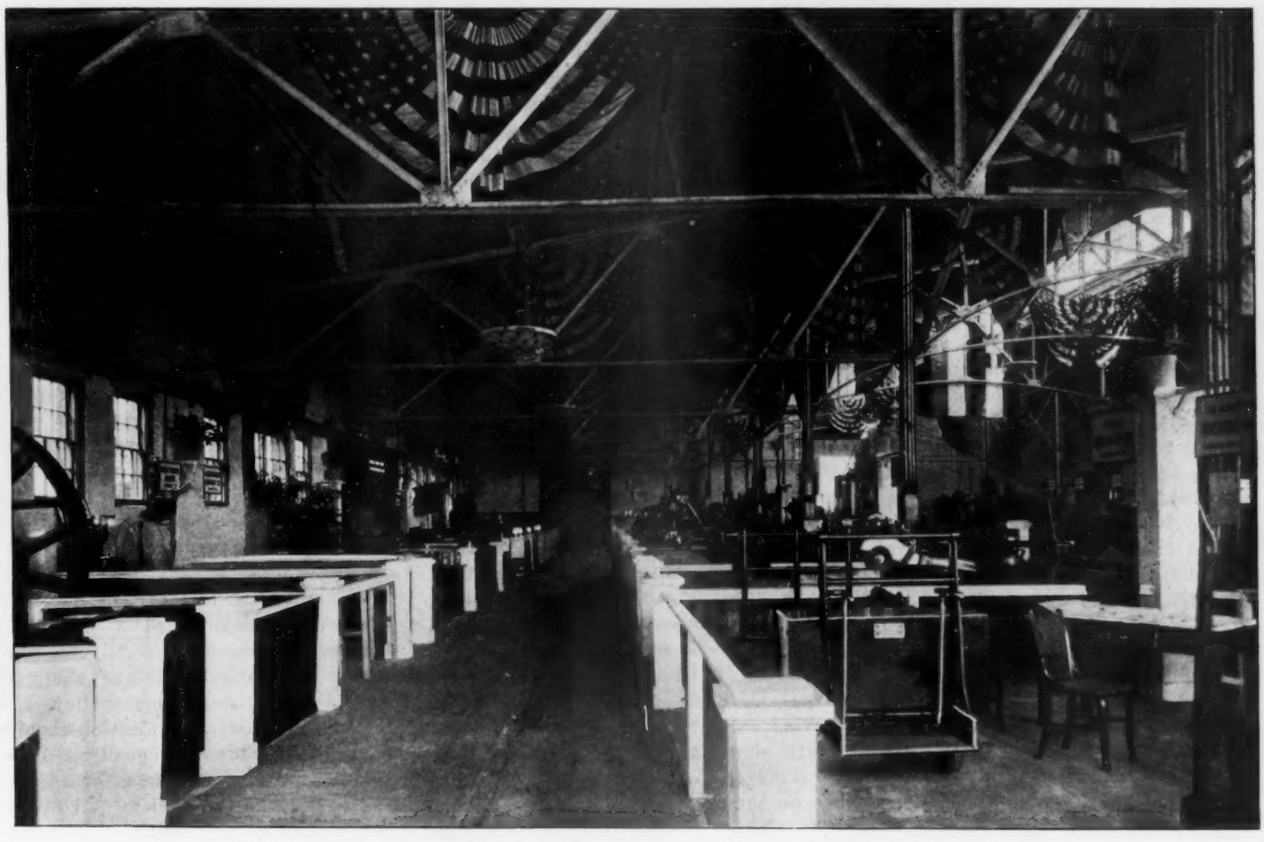
Exhibits of foundry supplies were made by the following: Hill & Griffith Co., Cincinnati; S. Obermayer Co., Chicago; T. P. Kelly & Co., New York; Osborn Mfg. Co., Cleveland; J. W. Paxson Co., Philadelphia; Buckeye Products Co., Cincinnati; Stanley Doggett, New York; J. S. McCormick Co., Pittsburgh; Peerless Parting Co., Ottawa, Ill.; Robeson Process Co., Pennington, N. J.; Silica Products Co., Chicago; Frederic B. Stevens, Detroit; United States Graphite Co., Saginaw, Mich.; Wyoming Shovel Co., Wyoming, Pa., and the E. J. Woodison Co., Detroit.

The line of non-ferrous melting furnaces exhibited by the Monarch Engineering & Mfg. Co., Baltimore, reflected great advances in the art during the last 12 months. One furnace of the portable type can be moved along the floor to pour off the molds and various tilting, stationary furnaces also were shown. Crucibles and other graphite products were displayed by the Joseph Dixon Crucible Co., Jersey City, N. J., and the Jonathan Bartley Crucible Co., Trenton, N. J., while the Gill Clay Pot Co., Muncie, Ind., had an extensive line of brass furnace liners, covers, base blocks and other fire clay products. Magnetic separators for brass foundry use were shown by the Dings Electro-Magnetic Separator Co., Milwaukee. Equipment for the plating department including dynamos, motor-generator sets, mechanical plating barrel, etc., was contained in the exhibit of the Bennett-O'Connell Co., Chicago.

Ingot brass mixtures and brass foundry metals were displayed by the following: Ajax Metal Co., Philadelphia; S. Birkenstein & Sons, Chicago, and the Great Western Smelting & Refining Co., Chicago; alloys, Goldschmidt Thermit Co., New York, and the Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

Furnaces for melting brass and non-ferrous metals were shown by the Hawley Down Draft Furnace Co., Easton, Pa.; Monarch Engineering & Mfg. Co., Baltimore; Whiting Foundry Equipment Co., Harvey, Ill., and the Ideal Furnace Co., Chester, Pa. Electric furnaces were displayed by the Hoskins Mfg. Co., Detroit, and the Whiting company exhibited a 4,000-pound steel converter.

That the testing of cores and core sand mixtures now is being more widely practiced in foundries than in recent years was reflected by the testing equipment for this work displayed by the Wadsworth Core Machine Co., Akron, O. For mixing the sand for laboratory purposes, a small pan mill is employed and small briquettes are made from the mixtures to be tested which are baked in a small gasoline-fired oven. The briquettes next are tested to ascertain their breaking strength and the results obtained not only serve as a check on the mixtures used from day to day, but also on the quality of the sands, oils and compounds purchased. For average foundry work, briquettes made from core mixtures will develop a tensile strength of 80 to 100 pounds per square inch, although some brass and aluminum cores will break at 30 to 40 pounds. An improved core jarring machine also was exhibited as well as two machines for making stock cores, etc. The Brown Specialty Machinery Co., Chicago, had a complete line of Hammer core machines, com-



ANOTHER AISLE IN THE BUILDING CONTAINING THE MACHINE TOOL EXHIBIT

plete with dies and core tapering and cutting-off machines. The Berkshire Mfg. Co., Cleveland, exhibited its redesigned Berkshire-Acme core machine.

For the transportation of material in foundries and other industrial plants various types of trucks were shown by the Automatic Transportation Co., Buffalo, and the Cowan Truck Co., Holyoke, Mass. Automobile trucks were exhibited by the Mercury Truck Co., Chicago.

The Carborundum Co., Niagara Falls, N. Y., and the Norton Co., Worcester, Mass., displayed an extensive line of refractory materials. Grinding machines were shown by E. O. Partridge, Chicago, and the Norton Co.

Pig Iron and Coke

More than 200 samples of pig iron of varying analyses were displayed by Rogers, Brown & Co., Cincinnati. This comprised one of the most complete line of samples of this kind ever collected. In addition, a pig of iron weighing 107 pounds was shown and in containers were displayed the varying amounts of iron ore, coke and limestone required to melt this amount of iron. A handsome display of by-product coke in the form of a replica of the Rock of Gibraltar was made jointly by Baird & West, Detroit, and Pickands, Brown & Co., Chicago. Samples of Mayari pig were displayed by the Pennsylvania Steel Co., Philadelphia.

The extensive line of goggles exhibited by the Julius King Optical Co., Chicago, and T. A. Willson & Co., Reading, Pa., reflected the widespread adoption of eye protection to safeguard the sight of industrial workers. Several new types of goggles were shown which embodied distinct improvements in design and construction.

Molding and core sands were exhibited by the following: Albany Sand & Supply Co., Albany, N. Y.; Garden City Sand Co., Chicago; Interstate Sand Co., Zanesville, O.; Ohio Sand Co., Conneaut, O., and the Superior Sand Co., Cleveland.

The following exhibits of core oils and core compounds were made: Cataract Refining & Mfg. Co., Buffalo; Crawford Oil & Chemical Co., Cleveland; Holland Linseed Oil Co., Chicago, and the Peterson-National Co., Chicago.

Steel sash and steel partitions, Pond continuous sash and sash-operating devices and the Pond truss for foundries and forge shops were displayed by the David Lupton's Sons Co., Philadelphia.

A wide variety of semi-steel castings, including automobile cylinders, gears, piston rings, etc., made with mixtures containing from 10 to 50 per cent steel were shown by McLain's System, Milwaukee. Throughout the week this exhibit attracted marked attention and hundreds of foundrymen were convinced of the beneficial effects to be derived from the addition of steel to gray iron to obtain increased strength, a close grain and excellent machining qualities.

Creosoted wood blocks for foundry and factory floors were exhibited by the Ayer & Lord Tie Co., Chicago. The floor of this booth was laid with these blocks and the photographs of wood block floors in various industrial plants were exhibited. The blocks are cut from selected long-leaf pine, air-dried and treated in such a manner that from 75 to 90 per cent of the shrinkage of the ordinary paving block is eliminated. For foundries, particularly light work shops, cleaning departments, casting storage warehouses, etc., this type of floor renders excellent service.

The Jennison-Wright Co., Toledo, also made an exhibit of creosoted wood blocks for flooring purposes. The floor of this booth was laid with creosoted blocks and photographs were displayed of floors installed in various industrial plants.

Pattern Shop Equipment

In various exhibits was contained practically the entire equipment required for pattern shop operations. The display of the Oliver Machinery Co. was unusually complete and included several new woodworking tools. Charles H. Besly & Co., Chicago, and the Gardner Machine Co., Beloit, Wis., exhibited disc grinders and pattern shop saws were shown by E. C. Atkins & Co., Indianapolis. The pattern lumber exhibit of the Thomas E. Coale Lumber Co., Philadelphia, proved a novelty and attracted much attention. Various grades of lumber were displayed and many woods adapted to pattern shop use were shown.

With 36 individual exhibits of machine tools, the progress of the past year in the design and construction of metal-working machinery was amply illustrated. The exhibits included working displays of all kinds of metal and woodworking machines. In spite of the great increase in the strength and power of machine tools in the past few years, it is evident that customers are not yet wholly satisfied in this direction. The demand for higher speeds and greater cutting ability is apparently as insistent as ever, but the demonstrations at the show made it plain that the machines now on the market have sufficient power to cut any grade of tool steel without stalling. Therefore, further progress toward greater capacity must come from the tool steel makers.

Machine Tool Improvements

The principal improvements of the past year in standard lathes, shapers, drill presses and milling machines include refinements in methods of motor drive, a simplification of the feed and speed change mechanism and advances in the direction of better finished machines and more handy arrangement for the convenience of the operator. Variable speed, direct current motors which reduce the amount of gearing necessary between the source of power and the working spindle are growing in favor, but there is also a tendency toward the adoption of squirrel cage induction motors due to the fact that in many localities direct current is not available without the use of motor generators. No machine tool is considered up to date at present unless the motor is sufficiently large to start the machine at any time under full load. In the latest motor-driven machine tools, all that the operator has to do in starting is to throw over a lever located in a convenient place on the machine or operate a push button. Automatic, magnetic starters regulate the proper input of current to the motors. This eliminates a great deal of trouble through burned out armatures.

Feed and speed change mechanism have undergone further simplification. With the exception of a few light drilling machines and shapers, one of the tools displayed was equipped with the old standard cone pulley. The demands of modern production require all geared heads and positive drive. Also, in the newest lathes, thread cutting is reduced to an elemental operation requiring no special knowledge of change gears or other mechanism on the part of the operator. The range of feeds and speeds seems to be constantly increasing and there were exhibited a 36-inch turret lathe with nine speed changes, ranging from 14 to 285 revolutions per minute, and a 14-inch, high duty shaper with a range of cutting speeds of from 10 to 130 strokes per minute.

The development of the turret lathe into a manufacturing machine with a wide range of possibilities was vividly illustrated by the displays on the convention floor. Also the adaptation of the gang drill to a multitude of operations ordinarily performed on a chucking lathe was illustrated.

The displays of grinding machines

demonstrated that the capacity of these tools at the present stage of their development is governed only by the limitations of abrasive materials. One of the most interesting machines of this class was a horizontal, gravity feed surface grinder for foundry use. The wheel was about 48 inches in diameter so equipped that castings with flat surfaces were held in contact by gravity without the use of chucks of any kind. All the workman has to do is to fit the castings to the machine, practically no skill being required, and the work is finished rapidly.

Woodworking machines came in for a large share of attention. It is evident that the builders of wood cutting tools have profited by the example of the builders of metal-working machines in striving for high speed, large capacity and practically automatic operation. One manufacturer exhibited a universal wood milling machine, which has practically as wide a range of operations as the latest standard metal milling machine. This tool is particularly useful in the pattern shop, where a large number of gear patterns are to be made. Another manufacturer exhibited a patternmaker's disc grinder, equipped with a 30-inch paper cemented steel disc wheel, and a 6-inch in diameter reciprocating sanding drum. The tool work tables of this machine are each adjustable in any direction, so that angular and irregularly-curved work may be shaped in minimum time. This machine performs practically all of the operations which the patternmaker ordinarily does by hand with the aid of a chisel, spokeshave and plane. The display of tools presented a wide range of selection for the pattern shop proprietor.

Fluxes for Soft Solders*

By W Arthur

AMONG the many metallurgical processes that of soldering is perhaps the most familiar. As ordinarily defined it is a process whereby two pieces of metal are joined by another metal or alloy, having a lower melting point than the metals joined.

That the metals soldered together may be securely held by the solder it is necessary that there be more than mere adhesion between the solder and the metal. There must be an alloy formed between the metal and the solder. In order that this alloy may be formed, the surface of the metal must be entirely free from any foreign substances such as oxides, oils, or various solid matter. Since it is not always convenient, or we may not care to take the time to clean the surfaces to be soldered, we resort to the use of various chemicals to clean the surfaces.

The flux selected in any particular case, is determined by the nature of the work. If ordinary tin plate, galvanized iron, sheet copper, or brass is to be soldered, the ordinary fluxes such as ammonium chloride, zinc chloride or resin may be used. But if the work is something more delicate, such as the soldering of fine zinc wires in fuse plugs, the effect of the corrosion of zinc chloride on the zinc wires must be considered.

It is necessary in many instances to use a non-poisonous flux, as a poisonous flux should not be used in soldering fruit or meat tins. In a great many operations it is impossible to keep the soldering flux from coming in contact with the operator's fingers, or occasionally spattering in the face.

The rapidity with which a flux acts is an important factor in its usefulness. If the flux be in the form of a dry salt, a comparatively large amount of heat may be necessary to melt it. If an aqueous solution be used, an additional large amount of heat must be used to evaporate the water, thus slowing the rate of action by cooling the parts to be soldered. This effect is negligible in most instances, but where it is necessary that the solder attach itself within a fraction of a second it becomes quite important.

If the flux does not require melting, but is a liquid, the action is much more rapid, as no time is required for the surface to be covered, and no heat is used in fusing the salt. Further, the excess flux, which should always be present, readily flows out of the way.

Zinc Chloride

Zinc chloride has several properties which makes it a valuable soldering flux for most work. It is only with the greatest of difficulty that it can be obtained as a dry salt, and when exposed to the air becomes liquid in a few minutes. When used as a flux it remains a liquid even at the temperature of molten solder, thus being in a condition to act upon the oxides very readily. It possesses other properties which make it undesirable for much work. Zinc chloride is poisonous, and should not be used in soldering fruit or meat tins. It is exceedingly corrosive to the skin, and when left upon it for a few minutes produces severe burns. It also has an action on zinc which makes it useless for soldering small zinc wires in fuse plugs. If low capacity fuse plugs be made, using chloride as a flux, the small zinc wires will be found to be completely eaten through within a few weeks.

An aqueous solution of ammonium phosphate was tried as a flux and worked quite well on tin, copper, brass or zinc, but not well on iron, where delicacy of operation and speed are not to be considered. But where a quick fluxing is necessary, it is not successful, as too much heat is necessary to evaporate the water and melt the salt. It has the advantage, however, of being non-poisonous and non-corrosive, and does not tarnish copper or brass.

Lactic acid and ammonium lactate were tested as to their fluxing qualities, and were found to be splendid fluxes, equal in every particular to zinc chloride, but in a few hours showed a tarnish if used to solder brass or copper. The reason for the ready tarnishing is that lactic acid and ammonium lactate react with copper oxide in the cold. Neither of these fluxes are corrosive or poisonous in any way.

Resin, either as a powder or an alcoholic solution, is a splendid flux where speed is not required. But it has the undesirable property of leaving a sticky, gummy mass after the evaporation of the alcohol, which is quite a hindrance in some kinds of work. Quite often a quantity of carbon and half decomposed resin is left where the solder is to follow. For ordinary work, where a non-poisonous flux is desired, resin is perhaps the most desirable.

An aqueous solution of citric acid is a good flux, having properties very similar to ammonium phosphate.

Ammonium chloride is a widely used flux, and is non-poisonous, and does not tarnish copper or brass.

*Presented at the Chicago convention of the American Institute of Metals.

Calculating Mixtures for Malleable Iron---II

The "Heald" System for Estimating Silicon, Which is Devised to Give the Content of This Element for Any Size Heat

By Harrold Hemenway

THE "Heald" system for calculating silicon is a method devised to give the silicon contents for any size malleable heat, provided the latter is figured at the average indicated for the silicon required, and certain grades of pig iron are used.

The sprue is figured as No. 5 iron having 0.60 per cent silicon and the different irons used are graded as No. 1, No. 2, No. 3 and No. 4, each having a certain percentage of silicon in exact proportion to each other. By having the different grades of pig iron in exact proportion to each other, and to the sprue figured as No. 5 iron having 0.60 per cent silicon, it is possible to make a card giving the exact silicon contents of the heats. This card will be universal and the silicon contents given can be used for any size heat desired, using any percentage of sprue, the silicon contents being increased or decreased as the average is decreased or increased.

Figuring the Grades

The sprue being figured as No. 5 iron having 0.60 per cent silicon, it is necessary to first determine the No. 1 iron. This is accomplished by taking the average silicon contents of the heats made during a stated period and determining what range of silicon is required in the mixture. In this case we have determined the No. 1 iron as having 1.52 per cent silicon and the other grades required are determined as follows:

No. 1 iron 1.52 per cent silicon
Sprue No. 5 iron —0.60 per cent silicon

$0.92 \div 4 = 23$

the number of points each grade must increase to be in exact proportion to each other, and to the sprue figured as No. 5 iron having 0.60 per cent silicon. This calculation is made as follows:

Sprue, No. 5 iron	0.60	per	cent	silicon
	+.23			
No. 4 iron	0.83	per	cent	silicon
	+.23			
No. 3 iron	1.06	per	cent	silicon
	+.23			
No. 2 iron	1.29	per	cent	silicon
	+.23			
No. 1 iron	1.52	per	cent	silicon

In this way it is only necessary to have four grades of pig iron on hand for every brand purchased, although it is advisable to have a small tonnage of other grades to be used when needed. The pig iron is arranged in four piles according to the analysis, and the first iron for each grade is laid on the ground in a long row. When other pig iron is received it is piled on top of this row, and according to the analysis of the iron being unloaded, it is put on the pile having its average silicon, allowing a variation of 10 points below and 15 points above the desired silicon.

When the piles have attained a certain height, other piles are started in the same manner, and the mixture is weighed from the completed piles, while the new piles are growing in height. When weighing the charges, the iron is taken from the end of each pile, thus insuring a perfect mix, and instead of using iron taken from one car for each grade, the charge is made up of iron taken from a large number of cars.

Using these irons for the mixture, the silicon contents for any size heat will be as follows, figuring the heat at the average indicated:

Silicon contents of heat, per cent.	Average.
1.152	2.60
1.129	2.70
1.106	2.80
1.083	2.90
1.06	3.00
1.037	3.10
1.014	3.20
0.991	3.30
0.968	3.40
0.945	3.50
0.922	3.60

To prove that this method can be used for any size heat, we will make up 6, 8 and 10-ton heats, having the same silicon contents, but using a different percentage of sprue for each heat. In calculating a mixture by this method, the different amounts used are always figured in even hundred pounds, and for this reason it is not necessary to consider the two ciphers in figuring a mixture. The different size heats will be written as follows:

6 tons, 120 instead of 12,000 pounds.
8 tons, 160 instead of 16,000 pounds.
10 tons, 200 instead of 20,000 pounds.

The silicon required in these mixtures is to be 1.014 per cent. By referring to the foregoing table we find that these heats must be figured at an average of 3.20, which multiplied by the size of the heat in pounds gives the base number from which to calculate the mixture. For a 6, 8 and 10-ton heat this base number is as follows:

6 tons	120	×	3.20	=	384
8 tons	160	×	3.20	=	512
10 tons	200	×	3.20	=	640

Taking the percentage of sprue required and subtracting this amount from the size of the heat in pounds, the remainder indicates the amount of pig iron to be used. If all of the pig used was to be graded as No. 2 iron, and using the sprue as No. 5 iron, a base number for a 6, 8 and 10-ton heat would be determined as indicated in Table I.

The heats in Table I have the same silicon contents and, therefore, it is not necessary to calculate the silicon, but merely to prove the calculation as indicated in Table II.

Since the different irons used multiplied by their averages and added equals the base number from which the calculation is made, the average must be 3.20 and the silicon contents of the heat 1.014 per cent.

Calculating the 6-Ton Heat

Calculating the 6-ton heat having a grade of 3.20 the base number is 384, and the base number, using 44 per cent sprue, is 399; subtracting 399 from 384 gives a remainder of —15. For this reason it is necessary to use 1,500 pounds more of No. 1 iron than No. 3 iron to obtain a grade of 3.20, making the amounts of iron used when multiplied by their grade numbers and added, equal 384. Using 1,500 pounds of No. 3 iron added to a —15 equals 3,000 pounds of the No. 1 iron, and these added and the result subtracted from 6,700 pounds equals 2,200 pounds of the No. 2 iron required.

In calculating the 8-ton heat having an average of 3.20 the base number is 512 and the base number using 40 per cent sprue is 512. Since the two base numbers are the same, the amounts of the No. 1 and No. 3 iron will be the same to obtain a grade of 3.20, making the amounts of iron used, when multiplied by their average numbers and added, equal 512. Using 3,200 pounds of No. 1 iron added to zero equals 3,200 pounds of the No. 3 iron, and these added and the result

subtracted from 9,600 pounds, equals 3,200 pounds, the No. 2 iron required.

In calculating the 10-ton heat having an average of 3.20, the base number is 640, and the base number using 36 per cent sprue is 616. Subtracting 616 from 640 gives a remainder of +24. For this reason it is necessary to use 2,400 pounds more of No. 3 iron than No. 1 iron to obtain a grade of 3.20, making the amounts of iron used when multiplied by their grade numbers and added, equal 640. Using 2,600 pounds of No. 1 iron added to +24 equals 5,000 pounds of the No. 3 iron, and these added and the result subtracted from 12,800 pounds, equals 5,200 pounds of the No. 2 iron required.

The amounts of malleable and steel scrap used are deducted from the total amount of sprue employed, and the grade of the heat is raised or lowered as the amounts are decreased or increased. Adding 100 pounds of steel scrap it is necessary to reduce the average 5 points, and when leaving out 100 pounds it is necessary to increase the average 5 points.

The three heats shown have the same grade and, therefore, the same silicon contents, but the amounts of malleable and steel scrap have been increased in the 8 and 10-ton heats. For this reason the 8-ton heat is a higher mixture than the 6-ton heat, while the 10-ton heat is a higher mixture than either the 6 or 8-ton heat. The size of the heat being taken into consideration, owing to the fact that the number of square inches of metal exposed to the top blast is not increased in proportion to the size of the heat, it is necessary to charge a higher mixture as the size of the heat is increased. Therefore, while these heats have the same silicon contents, they are each a little higher than the other owing to the amount of scrap used, showing how higher mixtures are obtained by varying the amount of scrap used.

Importance of Sprue Used

In calculating heats by this method the amounts of the different iron used depend upon the amount of sprue used, and the remainder obtained from subtracting these two base numbers determines whether it is necessary to use more No. 3 iron than No. 1 iron or *vice versa*. This remainder for the 6-ton heat is —15, which shows that the base number for the sprue is in excess of the base number for the grade of the heat. For this reason it is necessary to use 1,500 pounds more No. 1 iron than No. 3 iron to obtain a given silicon content for the mixture. This remainder will not be minus unless a large amount of sprue is used, and the sprue being the lowest silicon iron available, it naturally follows that we must use less No. 3 iron in obtaining a given silicon content, and this remainder governs the exact amount.

There is no remainder for the 8-ton heat as the two base numbers are the same; therefore, the No. 1 and No. 3 irons must be used in equal quantities. In this case, if no No. 1 and No. 3 irons had been used, the required silicon contents could have been obtained by using the No. 2 iron and the sprue.

This remainder for the 10-ton heat is +24, which shows that the base number for the average of the heat is

Table I.

How the Base Numbers for 6, 8 and 10-Ton Heats are Obtained and Method of Calculating the Mixtures.

6-Ton heat, 120 pounds.

44 per cent sprue, No. 5 iron..... — 53 × 5 = 265

No. 2 iron..... 67 × 2 = 134

120 = 399

8-Ton heat, 160 pounds.

40 per cent sprue, No. 5 iron..... — 64 × 5 = 320

No. 2 iron..... 96 × 2 = 192

160 = 512

10-Ton heat, 200 pounds.

36 per cent sprue, No. 5 iron..... — 72 × 5 = 360

No. 2 iron..... 128 × 2 = 256

200 = 616

The mixtures are calculated as follows:

	Silicon, per cent.	Amount, pounds.	Silicon in mixture.
No. 1	1.52	30 =	45.60
No. 2	1.29	22 =	28.38
No. 3	1.06	15 =	15.90
Sprue, No. 5	0.60 — 44 per cent	53 =	31.80
		120	121.68

121.68 ÷ 120 = 1.014 per cent of silicon the mixture contains.

3.20

384
399

67
45
22 No. 2

— 15
15 No. 3
30 No. 1
45

Malleable scrap, 400 pounds.
Steel scrap, 300 pounds.

	Silicon, per cent.	Amount, pounds.	Silicon in mixture.
No. 1	1.52	32 =	48.64
No. 2	1.29	32 =	41.28
No. 3	1.06	32 =	33.92
Sprue, No. 5	0.60 — 40 per cent.	64 =	38.40
		160	162.24

162.24 ÷ 160 = 1.014 per cent of silicon the mixture contains.

3.20

96
64
32 No. 2

512
512
0
32 No. 1
32 No. 3
64

Malleable scrap, 600 pounds.
Steel scrap, 500 pounds.

	Silicon, per cent.	Amount, pounds.	Silicon in mixture.
No. 1	1.52	26 =	39.52
No. 2	1.29	52 =	67.08
No. 3	1.06	50 =	53 00
Sprue, No. 5	0.60 — 36 per cent	72 =	43.20
		200	202.80

202.80 ÷ 200 = 1.014 per cent of silicon the mixture contains.

3.20

128
76
52 No. 2

640
616
+ 24
26 No. 1
50 No. 3
76

Malleable scrap, 900 pounds.
Steel scrap, 700 pounds.

in excess of the base number for the sprue. For this reason it is necessary to use 2,400 pounds more of the No. 3 iron than the No. 1 iron to obtain a given silicon content for the mixture. By using less sprue it naturally follows that we must use more No. 3 iron to obtain a given silicon content, and this remainder governs the exact amount.

These three heats show how carefully and completely this method is devised, as since the different grades are in exact proportion to each other, the same silicon contents can be obtained, whether the two base numbers are equal or there is a remainder with plus or minus. When the remainder is a plus number the amount added to this number will be the No. 1 iron, whereas if this remainder is a minus number, the amount added to this number will be the No. 3 iron. By decreasing the grade, the silicon content is increased, and by increasing the grade the silicon content is decreased.

In the 10-ton heat referred to, the No. 2 and No. 3 irons have been used in large quantities, and these piles will be drawn upon the heaviest. If it is necessary to run a higher mixture and being unable to increase the percentage of sprue used, and desiring to use less of the No. 2 and No. 3 irons, a mixture is made up containing No. 4 iron. The silicon required in this mixture is to be 0.945 per cent. By referring to the foregoing table we find that the heat must have an average of 3.50 and the calculation is made as shown in Table III.

Table II.

How the Calculation is Proved.

6-Ton heat	120				
No. 1 iron.....	30	×	1	=	30
No. 2 iron.....	22	×	2	=	44
No. 3 iron.....	15	×	3	=	45
Sprue, No. 5 iron.....	53	×	5	=	265
	120			=	384
8-Ton heat	160				
No. 1 iron.....	32	×	1	=	32
No. 2 iron.....	32	×	2	=	64
No. 3 iron.....	32	×	3	=	96
Sprue, No. 5 iron.....	64	×	5	=	320
	160			=	512
10-Ton heat	200				
No. 1 iron.....	26	×	1	=	26
No. 2 iron.....	52	×	2	=	104
No. 3 iron.....	50	×	3	=	150
Sprue, No. 5 iron.....	72	×	5	=	360
	200			=	640

In calculating the 10-ton heat having an average of 3.50, the base number is 700 and the base number using 36 per cent sprue is 616. Subtracting 616 from 700 leaves a remainder of +84. For this reason it is necessary to use 8,400 pounds more of No. 3 iron than No. 1 iron. Using 2,600 pounds of No. 1 iron added to +84 equals 11,100 pounds of the No. 3 iron, and these two added would equal 13,600 pounds, which is in excess of the 12,800 pounds required to make up a 10-ton heat, using 36 per cent sprue. By using 3,000 pounds of No. 3 iron, which amount is subtracted from 11,100 pounds, leaves a remainder of 8,000 pounds, and this amount divided by 2 equals 4,000 pounds of the No. 4 iron. The No. 1, No. 3 and No. 4 irons added equal 9,600 pounds, and this result subtracted from 12,800 pounds equals 3,200 pounds of the No. 2 iron required. The calculation is proved as follows:

No. 1 iron.....	26	×	1	=	26
No. 2 iron.....	32	×	2	=	64
No. 3 iron.....	30	×	3	=	90
No. 4 iron.....	40	×	4	=	160
Sprue, No. 5 iron.....	72	×	5	=	360
	200			=	700

Since the different irons used, multiplied by their averages and added equal the base number from which the calculation is made, the average must be 3.50 and the silicon content of the heat, 0.945 per cent.

Two Heats From One Furnace

Table IV shows how to calculate heats for one furnace running two heats on a cast day, the first heat to have the silicon content 0.945 charged into a hot furnace.

The amounts of malleable and steel in Table IV must be weighed for each heat and deducted from the amount of sprue used. Suppose the first heat proved to be a little soft and it was necessary to continue the metal in the furnace some time (to completely combine the carbon) after the metal was hot enough to pour the class of work being made in that particular furnace. It then is necessary to have a higher mixture for the second heat and also an 11-ton heat which is one ton larger than the heat which has already been weighed.

By referring to the average table we find that a heat having an average of 3.60 will have a silicon content of 0.922 per cent, which is the silicon required. An 11-ton heat having an average of 3.60 has a base number of 792. Subtracting 700 (the base number used in calculating the heat) from 792 leaves a remainder of +92 points. For this reason 2,000 pounds must be added to equal +92 points. The change is made as follows:

No. 4 iron +	8	x	4	=	+ 32
No. 5 iron +	12	x	5	=	+ 60
	20			=	+ 92

By adding 800 pounds of the No. 4 iron containing silicon, 0.83 per cent and 1,200 pounds of sprue with a silicon content of 0.60 per cent, the heat has been increased to 11 tons, and the irons added are in such proportion that the average is 3.60 and, therefore, the silicon contents is 0.922 per cent.

It is not necessary to use the irons having the same silicon as were used in calculating the heats given in Table IV, and a change in the irons may be necessary to give the proper range of silicon contents for the different heats. Irons having different silicon may be used, if they are in exact proportion to each other and to the sprue, which also does not have to be used as having 0.60 per cent silicon as a higher or lower percentage also can be employed. The reason that the sprue has been figured at 0.60 per cent silicon in the examples given, is due to the fact that this is a fair proportion for the average run of malleable work.

Having selected the grades of iron to be used, a heat card can be made up showing at what average the mixture must be figured to obtain the desired silicon contents. This card can be made to show the silicon contents for more heats than given in this article, as the averages, as given, are increased by ten points each time while they can be advanced five points each time if desired. The averages also can be increased above 3.60 which will give a lower silicon content to the mixture. It is not possible to increase the average above 4.00 advantageously as the base number will be so large it will be out of proportion with the base number for the sprue.

If a lower silicon mixture is required than the card indicates this can be obtained by leaving out the No. 1 iron and using the other irons graded as No. 1, No. 2, No. 3 and No. 5, making up the mixture as shown in Table V and explained in the

Table III.

Figuring the 10-Ton Heat with a Lower Percentage of Sprue.

	Silicon, per cent.	Amount, pounds.	Silicon in mixture.
No. 1	1.52	26 =	39.52
No. 2	1.29	32 =	41.28
No. 3	1.06	30 =	31.80
No. 4	0.83	40 =	33.20
Sprue, No. 5	0.60	— 36 72 =	43.20
		200	189.00
	189 ÷	200 =	0.945 per cent of silicon the mixture contains.
	3.50		
	128	700	
	96	616	
	32 No. 2	+ 84	
		+ 26 No. 1	26
		110	30
		— 30 No. 3	40
		2) 80	96
		40 No. 4	

Malleable scrap, 900 pounds.
Steel scrap, 700 pounds.

previous article published in THE FOUNDRY in October, 1913.

The three heats in Table VI were run on the day and date indicated. The first heat had an average of 3.20, the second 3.35, and the third 3.40. Below these numbers, I use an average number, being a number to indicate the condition of iron at the time of testing, and understanding these numbers, I can tell whether the silicon should be increased or decreased, in the next heat.

The numbers listed at the extreme right show exactly what silicon the different grades should have to be in exact proportion. Thus by knowing what average the last heat was figured at and its grade, it is possible to know what average should be used on the next day's run. Having determined this, it is easy to look up the base number on the card, and calculate the mixture. If any new irons are to be used, by referring to the figures on the extreme right, which will show that the irons used were not in exact proportion, one can judge by the silicon in the new iron to be used, whether it is necessary to vary the average to make up for the difference in silicon between the two irons. The term, *As 400*, means anneal scrap 400 pounds and *Steel 300* means steel scrap, 300 pounds.

It will be noted that three heats were run, but owing to the hot weather and light work, these were not very large. The time of charging and tapping each heat is indicated at the left of the heat, charging at 3 o'clock, 7:50 and 1 o'clock, tapping at 7 o'clock, 11:20 and 4:30. The time of charging indicates the time the bung was raised, and, therefore, includes the time of charging.

Table V.

FIGURING A LOW SILICON MIXTURE.

	Silicon, per cent.	Amount, pounds.	Silicon in mixture.
No. 1	1.29	25 =	32.25
No. 2	1.06	40 =	42.40
No. 3	0.83	55 =	45.65
Sprue No. 5	0.60 — 40	80 =	48.00
		200	168.30

168.30 ÷ 200 = 0.842 per cent of silicon the mixture will contain.

3.35
670
120 640
80 —
+30
40 No. 2 25 No. 1
55 No. 3
80

Malleable scrap, 900 pounds.
Steel scrap, 700 pounds.

The amount at the bottom, 39,500, shows the daily melt, and is written there to assist in making the weekly record. This will show a complete day's record and will indicate why the average is needed in this system.

By this method it is possible to obtain a large range of silicon for any size heat, which makes it universal, as the silicon contents can be raised or lowered for any size heat required. The heat card also shows the base number for the different averages, the percentages of sprue and pig iron required together with the base number for the different percentages of sprue. Having the cards properly made out it will only require a little study of furnace conditions from day to day to determine what silicon contents the charge should contain to keep the product within certain well-defined limits.

Table IV.

CALCULATING TWO HEATS FROM ONE FURNACE.

	No. 1 Furnace Silicon, per cent.	Per cent.	Silicon, 0.945 per cent.		Silicon, 0.922 per cent.	
No. 1.....	1.52		26		26	
No. 2.....	1.29		32		32	
No. 3.....	1.06		30		30	
No. 4.....	0.83		40		40 + 8 = 48	
Sprue No. 5.....	0.60 — 36 to 38		72		72 + 12 = 84	
			200		200	220
			3.50		3.50	3.60
		128	700		700	792
		96	616	128	616	700
		32	No. 2 +84	96	+84	+92
			+26 No. 1	32	No. 2 +26 No. 1	
			110		110	
			—30 No. 3	26	—30 No. 3	26
				30		30
			80 ÷ 2	40	80 ÷ 2	40
			40 No. 4	96	40 No. 4	96

Malleable scrap, 900 pounds.
Steel scrap, 700 pounds.

Value of Method

This method will appeal to the up-to-date manager, as it will permit the superintendent or foundry foreman to have direct charge of the heats and still save them time in calculating the mixtures. In larger plants operating a great many furnaces, where a special man is required to calculate the mixtures, any employe with a common knowledge of figures can master this system. By carefully studying the different furnace conditions, together with the analysis furnished by the laboratory, he will become so proficient in calculating the mixtures, that he soon will improve the quality of the finished product. This can be done in various ways too numerous to mention in this article, and also in a great many cases the melting time can be reduced.

Wherever this system is used, it will be a great help to the selling agents for the blast furnaces, as it greatly reduces the demand for pig iron having an exact analysis as regards silicon.

Table VI.

RECORD OF THREE HEATS FROM FURNACE NO. 2, THURSDAY, JULY 21.

Pig iron.	Silicon, per cent.	Heat No. 17, silicon, 0.986 per cent.	Heat No. 18, silicon, 0.955 per cent.	Heat No. 19, silicon, 0.947 per cent.
I. B. No. 1.....	1.41	29	30	33
Charcoal, No. 2	1.26	24	18	20
B. V. No. 3.....	0.87	12	12	12
Gates and sprues, 4,750 pounds.	0.52	65	60	70
		140	120	135
		3 a. m. 3.20	7:50 a. m. 3.35	1 p. m. 3.40

As. 400 pounds.
Steel, 300 pounds.

39,500

The Spotting-Out Problem and Silver-Plating*

A Discussion of This Phenomenon With Remedies for the Prevention of the Occurrence of These Spots on Plated Work

By C F Burgess and L T Richardson

SPOTTING-OUT is one of the nightmares of the electroplater. Though one may seek long through scientific literature for a formal name and classification of this metallurgical disease, every practical worker can diagnose it on sight, though often unable to apply the perfect remedy. Spotting-out, as the workers call it, may occur on almost any kind of plated surface, but it is with special reference to silver-plated ware that this paper deals.

When the silver surface leaves the plating and polishing rooms it may be bright and flawless, but upon standing for some time exposed to the atmosphere it develops spots. Illustrations of this may be found by examining closely almost any silver-plated reflector for electrical headlights on automobiles. These spots appear as a white tarnish in circular or oblong form, and they may eventually develop far enough to interfere seriously with not only the appearance, but the efficiency of the reflecting surface.

Development of Spots

Dampness in the atmosphere is an accelerating agent, and there are various factors in the manufacturing processes which may influence the degree to which the spots will develop.

It is claimed by one authority that spotting-out is due to imperfections in the underlying metal, and more often to pitting due to gas bubbles at the cathode resulting from too high a current density or too much free cyanide or acid. Another writer states that it is due to the porosity of metal which absorbs the cyanide. It gives more trouble in summer than in winter. Another states that it is due to blisters from plating solutions too strong in cyanide. In fact, it is the general opinion that cavities due either to defects in the underlying metal or defects in the coatings which allow the inclusion of electrolyte constitute the cause of spotting.

Among the remedies suggested are the following:

Subjecting the finished work to alternate hot and cold water, the contraction and expansion forcing the solution out of the cavities. Another recommends boiling after plating in a solution of argol, two ounces to the gallon, and then heating in an oven to 160 degrees Fahr. for several days. Another recommends washing and drying the articles thoroughly and then letting them remain unfinished for several days or weeks. Another recommends leaving the finished work for some weeks in a dry, hot atmosphere. In fact, the most generally recommended remedy appears to be the removal of the enclosed solutions by rinsing or long-time boiling in water. Various authorities deprecate the use of solutions which liberate gas at the cathode, and for silver plating caution against the use of too much free cyanide. Low current density appears to be advantageous.

Table I.

DELIQUESCENT PROPERTIES OF MATERIALS AS PURCHASED.

Salt used.	Weight taken, grams.	Hours standing.	Grams water absorbed.	Water in per cent. of salt.
NaCN— C. P.	2.0	3	0.581	29
		7	1.085	54
		23	1.908	95
		71	3.899	195
KCN— C. P.	2.0	3	0.358	18
		7	0.603	30
		23	0.99	50
		71	1.956	98
NaCN— Commer.	2.0	3	0.597	30
		7	1.081	54
		23	2.025	101
		71	3.76	188
NaCN— 80 per cent NaCl— 20 per cent	2.088	19	1.889	95
		67	3.426	164

SUMMARY.

Hours standing.	NaCN C. P.	NaCN commercial.	KCN C. P.	Per cent of water absorbed by NaCN–80 per cent. NaCl–20 per cent.
3	29	30	18	..
7	54	54	30	..
19	..	..	..	95
25	95	101	50	..
67	..	..	..	164
71	195	188	98	..

Various recommendations are found favoring the use of sodium salts instead of potassium on the basis of their lesser deliquescence. A question which is frequently debated is whether the cavities holding solutions are due to the imperfections of the brass, or to the methods of preparing the surfaces, or to defects in the electroplated coating. The natural tendency of human nature to throw responsibility for trouble on the shoulders of others, has given rise to some controversy between the plater and the brass manufacturer. The former asserts that pits and porosity of the underlying metal are responsible for flaws in the finished product, while the brassmaker asserts that the problem of preventing spots is up to the plater.

It is easy to see why in brass castings there may be pits and porous spots which in subsequent plating may be covered up and thus enclose solutions which would give rise to the later corrosion and discoloration, but it is not so easy to dispute the manufacturer of high-grade rolled sheet brass who asserts that the rolling and densifying mechanical processes to which his product is subjected precludes the existence of pits and porosity. He claims that even though there may have been a pit in the ingot, the rolling operation will gradually elongate and narrow it until it practically disappears.

Inspection of Rolled Brass

A careful study was made of a certain high-grade quality of sheet brass to determine, if possible, the existence of pits or segregations which may have been the nucleus of spots on the silver plated surfaces. This study was largely carried out by means of the microscope. Many spots were examined microscopically and the surface was gradually polished down in progressive steps by a metallographic grinder. In most cases no defects in the underlying metal could be detected, but in at least one case it was possible to follow the defects down into the body of the brass. In this case there appeared to be a black material like a cinder imbedded in the softer metal. This explains the possibility of the existence of pits in rolled brass. There is no doubt that the rolling operations greatly limit the presence of pits or cavities, but it can be seen that a hard, brittle material imbedded in the soft metal may retain its original shape, even during

*Presented at the Chicago Convention of the American Institute of Metals.

the rolling operation, and on coming to the surface through polishing or grinding operations may be removed, thus leaving a cavity. As far as the writers have observed, however, this is an unusual occurrence.

A careful examination of spots shows that there are several varieties, due probably to different factors. They may have clearly defined outlines, they may be mere specks of cloudiness, or larger masses of white coloration merging gradually into the bright polished silver. Some spots attain their maximum growth and intensity within a few hours or days, while others appear to grow indefinitely. The discoloration is usually white, but it may also be gray or black, although there is a distinct difference between spots and tarnish such as is caused by atmospheric sulphur.

It was noted that by far the greater majority of spots examined had a central point or nucleus which appeared as a perforation through the silver layer. Some of these could be observed by the naked eye, while others required the microscope to reveal them. Usually appearing through these spots is a growth of material of a black or greenish appearance. This sometimes takes a worm-like formation, growing a considerable distance from the central opening. The material constituting this growth appears to be deliquescent, attracting moisture, and on a damp day the drops of moisture surrounding these spots are readily discernible under the magnifying glass. It is where this condensation of moisture occurs that the discoloration apparently takes place, and explains why the spotting is much more in evidence in summer than in winter, due to the greater humidity of the atmosphere during warm weather. The material growing out of these perforations was insufficient in quantity to allow of the collection of an amount large enough for analysis.

Table II.

DELIQUESCENT PROPERTIES OF MATERIALS AFTER EVAPORATION AND DRYING AT 100 DEGREES CENT.

Salt used.	Weight taken, grams.	Hours standing.	Grams water absorbed.	Water in per cent. of salt.
NaCN Commercial	1.4045	3	0.584	42
		19	1.794	128
		67	2.659	189
NaCN C. P.	2.0875	3	0.517	25
		19	2.129	102
		67	4.048	196
KCN C. P.	2.0	3	0.557	30
		19	1.123	56
		67	2.700	135

SUMMARY.

Hours standing.	Per cent water absorbed by NaCN commercial.	NaCN C. P.	KCN C. P.
3	42	25	30
19	128	102	56
67	189	196	135

The appearance seemed to indicate the presence of copper and zinc compounds, and by means of applying a prepared filter paper a distinct test for cyanide was made in various cases.

By placing a drop of a cyanide solution on a silver surface a white discoloration takes place similar in appearance to the spotting under investigation. This, together with the chemical evidence of cyanide, confirms the general belief that cyanide compounds are largely responsible for the spotting-out on silvered surfaces.

Electrochemical Action

The formation of spots is easily explained on theoretical grounds, the explanation being similar to that for the pitting and rusting of iron. It is an electrochemical action. The brass and silver constitute an electrochemical couple, and the electrolyte enclosed in the cavity furnishes the additional element of an electrolytic cell. There may be electrochemical action whether or not there is a communication through the silver coating to the atmosphere. The presence of such communicating channel will greatly stimulate corrosion. The air furnishes the depolarizing agent which accelerates the electrochemical action. Since the copper and zinc of the brass are electropositive to silver, it is these materials which are corroded to form compounds and constitute the worm-like growths previously referred to.

It is evident that if the work be carefully dried, all of the moisture may be driven out of the cavity. No chemical action can take place, as there is no electrolyte, but due to the deliquescent properties of the material in the cavity, this deficiency is quickly removed and the chemical action is started. Since the electrolyte may serve simply as a conducting medium and not necessarily be consumed as the underlying metal corrodes, it is possible that a small amount of enclosed chemical may be responsible for a large amount of corrosion product.

The included chemical material may be from the pickling bath, the strike solution, or the regular plating solution. Although this material originally may be entirely covered by the plating metal, the perforation may be effected by the polishing operation or by the corrosion which forces its way through the silver surface. The cavities enclosing the solution may be exceedingly minute. Attempts to make artificial cavities by means of the point of the finest needle failed to give any results. Porosity in the brass may be present without showing itself under the microscope. By placing a small drop of hydrocholoric acid solution on a brass surface the zinc is dissolved out, leaving a copper-colored spot. This has a high degree of porosity, and various cases were noted where the presence of such copper spots produced spotting-out on a silver plated surface.

On a perfectly polished brass surface cavities may be formed by the adhering gas bubbles. These bubbles may come from the pickling or cleaning solution, or they may be formed while in the plating baths. As the plating deposit grows up around these bubbles, the cavities are thus formed, which may allow the entrance and inclusion of the solution. If such cavities are largely responsible for spotting-out, further attention should be concentrated on this particular feature. It is common practice to plate nickel upon the brass before the deposition of silver, and it is possible that the cavities due to bubbles may decrease by omitting the nickel layer.

Table III.

DELIQUESCENT PROPERTIES OF SALTS EVAPORATED FROM PLATING SOLUTIONS.

Solutions.	Weight taken.	Hours standing.	Water absorbed grams.	Water absorbed in per cent.
No. 1	2.793	21	1.772	63
		24	2.285	82
		28	2.549	91
		44	2.960	106
		92	3.541	127
No. 2	2.447	21	2.166	80
		24	2.732	111
		28	3.091	126
		44	3.628	148
		92	4.328	177
No. 3	0.917	21	0.687	75
		24	0.805	88
		28	0.861	94
		44	0.756	83
		92	0.703	76

SUMMARY.

Hours standing.	Per cent water absorbed by solutions. No. 1.	No. 2.	No. 3.
21	63	80	75
24	82	111	88
28	91	126	94
44	106	148	83
92	127	177	76

All cyanide or silver plating solutions have a certain amount of free cyanide, an excess above that required for taking the silver cyanide into solution. This excess amounts to a fraction of an ounce—to several ounces per gallon in the plating bath—and from 10 to 20 ounces in the strike solution. Cyanides are deliquescent and attract moisture from the atmosphere, as may be readily determined by placing a small amount of either potassium or sodium cyanide in a granulated form in a glass or porcelain vessel. In a few hours or perhaps a few days enough moisture is attracted to

(*Continued on page* 509)

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The Chicago Meeting

THAT rule-of-thumb methods, which have persisted in foundry operations for many years, are being replaced rapidly by scientific practice, was reflected by the papers and discussions at the recent annual conventions of the American Foundrymen's Association and the Institute of Metals. The attendance and the interest manifested in the proceedings of both organizations was gratifying and foreshadowed an era of still greater usefulness for both societies. More efficient management of casting shops with lower costs of production undoubtedly will result from the consideration of a number of able papers on "Scientific Management". This subject aroused great interest and the experiences related by many foundrymen who have improved their methods of operation clearly pointed out the dangers that must be avoided while introducing a system that provides for greater efficiency, increased output and higher wages. To prevent the creation of dissension among the employes is the most difficult task that accompanies the introduction of this practice and tact is required to accomplish the results which ultimately will prove beneficial to both employer and employe. It was the consensus of opinion, that piecework prices, when once established, should be fixed for at least a year, and when the molder, molding machine operator or other workman once is convinced that an increased output will result in higher and not in lower wages, the difficulties besetting the introduction of so-called "Scientific Management", to a large extent, will have been overcome. Both societies will co-operate in the preparation of a uniform cost system intended to replace the standard method adopted a number of years ago, and which today is practically obsolete. Uniform cost methods, to a large extent, will eliminate the evils of the foundry industry resulting from low prices engendered by an ignorance of actual costs of production. The appointment of committees to carry on a large part of the work of the American Foundrymen's Association was another step forward which will be productive of excellent results. The Institute of Metals is co-operating with the United States Bureau of Standards and Bureau of Mines in an investigation of melting difficulties, the adoption of a standard test bar and the standardization of non-ferrous alloy nomenclature. A bulletin covering brass foundry melting practice shortly will be issued by the government, which will represent the results of the first investigation of this subject that has ever been undertaken. A standard test bar will remove many conflicting theories that now are held regarding the form and size of this piece, and data covering the temperatures at which the various alloys should be cast should prove of inestimable value to the brass foundry trade. The chaotic state of alloy nomenclature promises to be cleared by the work that is now being done and the system suggested in a report presented elsewhere in this issue is worthy of the most careful consideration. Owing to the difficulty experienced in obtaining papers, it was decided to return to the late spring or early summer meetings, and it is believed that this change will result in a much larger attendance than either at Buffalo or Chicago. The exhibition of foundry equipment, accompanied by a wonderful display of machine tools, surpassed all expectations. In space occupied, number of exhibits and attendance all records were broken and the show was a tribute to the painstaking efforts of the Foundry & Machine Exhibition Co., under whose auspices it was held.

New Equipment for the Foundry and Pattern Shop

Combination Jar-Ramming, Roll-Over and Pattern-Drawing Machine—
Clam-Shell Bucket—Truck Core Ovens—Air Compressor—Melting Pots

OWING to the great economy effected in ramming molds by the jarring process numerous combinations of this simple pneumatic machine have been introduced whereby the remaining mold-making operations are performed mechanically and by which rolling-over and drawing the pattern by hand are accomplished by the machine. By the incorporation of these devices in this type of machine, the making of molds is practically automatic and the only labor involved, not mechanically-performed, consists of carrying away and closing the mold.

An exceedingly simple machine of the jar-ramming type equipped to roll-over the mold and draw the pattern has been designed by the Federal Foundry Supply Co., Cleveland, and is shown in the accompanying illustration. The roll-over device is so attached that the machine can be converted quickly into one of the plain jarring type, if work is to be made not requiring the roll-over attachment. The machine consists essentially of a jar-ramming cylinder and table for ramming the mold. Two sides of the table, however, are extended and contain the eyes for a bar which is inserted to form a hinge for rolling-over the pattern plate and mold. To the bar are attached two arms, clearly shown in Fig. 5, to which the pattern plate is bolted.

FIG. 2 — FLASK ON TABLE FILLED WITH SAND BEFORE RAMMING

When a mold is to be made, the pattern rests on the table for the jar-ramming machine, as indicated in Fig. 1. After the flask is set in position and filled with sand, the mold is rammed by admitting air to the cylinder, and after the mold has received a sufficient number of blows to pack the sand to the required consistency, the sand is struck-off and the bottom board is clamped in position. In Fig. 2 the operator is about to admit air into the jar-ramming cylinder, and in Fig. 3 the mold is being rolled-over after clamping. In Fig. 4 the mold has been rolled-over and levelled, the clamps removed and the operator is about to admit air into the jar-ramming cylinder to draw the mold. As previously stated, the roll-over device is hinged to the jar-ramming table and by the upward movement of the latter the mold is drawn. This operation is shown in Fig. 5, in which the pattern has been drawn, and it will be noted that the table of the machine likewise has been elevated to effect this draw.

After the pattern has been drawn, the pattern plate is rolled back on its hinge onto the jar-ramming table, which is then lowered and is in position to receive another flask. In the meantime the mold previously made is carried away.

By the removal of a bar inserted through the eyes in the extension of the machine table and corresponding openings in the roll-over arms, the entire roll-over device can be quickly re-

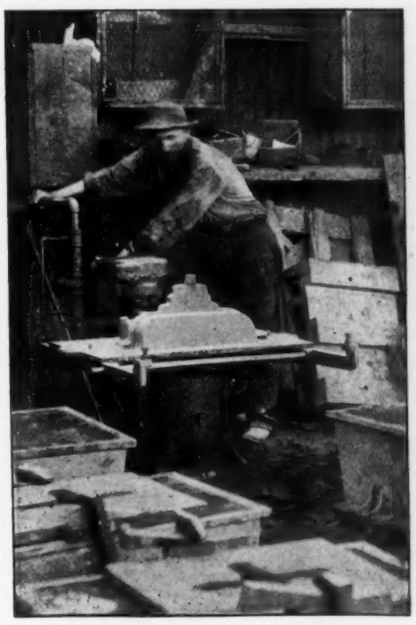


FIG. 1—COMBINATION JAR-RAMMING, ROLL-OVER, PATTERN-DRAWING MACHINE WITH PATTERN ON TABLE

FIG. 3—ROLLING OVER THE MOLD AND LOWERING IT ONTO THE FLOOR TO BE LEVELLED

FIG. 4—THE MOLD LEVELLED AND CLAMPS REMOVED PREPARATORY TO DRAWING THE PATTERN MECHANICALLY

moved. Cores can be made with equal facility, the core box being attached to the roll-over arms in place of the pattern plate. The jar-ramming and pattern-drawing operations are controlled by one lever obviating the necessity of the operator leaving his station while these movements are performed.

Self-Contained Clam-Shell Bucket

For handling sand in foundries and for other similar industrial purposes, the Euclid Crane & Hoist Co., Euclid,O., has designed a self-contained clam-shell bucket which can be suspended from any hoist or crane of sufficient capacity to lift the loaded bucket and to carry it from one point in the shop to another.

As shown in Figs. 1 and 2, an electrically-operated hoist is supported by a structural steel framework, to which the operating arms of the bucket are attached. The electric hoist is of standard type built by the Euclid Crane & Hoist Co. and the motor is protected by an automatic slip clutch and cut-out. The bucket is of the single type and is designed for suspension from any standard crane having only one hoist hook. The hoist opens and closes the bucket and the crane from which this bucket is suspended lifts the latter with its load. The bucket, therefore, is ready for operation when suspended from a crane or hoist hook. The entire hoisting apparatus and electrical connections are protected in such a way that they are not injured by rough handling.

The contract for the roofing for the Railway Exchange building, St. Louis, involving 67,500 square feet of material, was awarded to the H. W. Johns-Manville Co., New York City.

FIG. 5—DRAWING THE PATTERN

Personal

Weaver H. Rogers, newly elected vice president and general manager of the Pittsburgh Iron & Steel Foundries Co., Midland, Pa., will have the direct management of the company.

James Murray has resigned as general foreman of the General Fire Extinguisher Co., Auburn, R. I., to become superintendent of the Springfield Foundry Co., Springfield, Mass. The employes at Auburn presented him with a suit case.

Edgar Allen Custer, whose investigations of gray iron foundry practice led to the development of the permanent mold, has withdrawn from the Sandless Casting Machine Co., and now is engaged in consulting engineering work with an office at Forty-first street and Baltimore avenue, Philadelphia.

R. E. Turnbull, for many years affiliated with Henry E. Pridmore, Chicago, now is associated with the Arcade Mfg. Co., Freeport, Ill., manufacturer of a complete line of molding machines.

J. F. Gaffney, sales manager of the pig iron department in the Ontario, Can., district for Drummond-McCall & Co., Montreal, has resigned to accept a similar position with R. J. Mercur & Co., Ltd., Montreal.

E. Arthur Tutein, Exchange building, 53 State street, Boston, has been appointed exclusive sales agent in New England for the sale of pig iron manufactured by the Thomas Iron Co., Easton, Pa.

A recent issue of the *Obermayer Bulletin*, issued by the S. Obermayer Co., Chicago, contains a sketch of the career of William M. Fitzpatrick, who has had a wide experience as a salesman in the foundry supply trade. At the age of 16 years he first caught sight of a foundry and four years later he received his degree as a molder. At the age of 21 he was discovered by the late Simon Obermayer, and for 22 years he has continuously been in the service of the Obermayer company. Mr. Fitzpatrick is at home at Reading, Pa.

A portable electric tool for drilling small holes in metal and wood, which can be attached to an ordinary incandescent lighting socket with either alternating or direct current, now is being manufactured by the Independent Pneumatic Tool Co, Chicago. The drills are equipped with universal motors, which can be operated on 110 or 220 volts, direct or single phase alternating current.

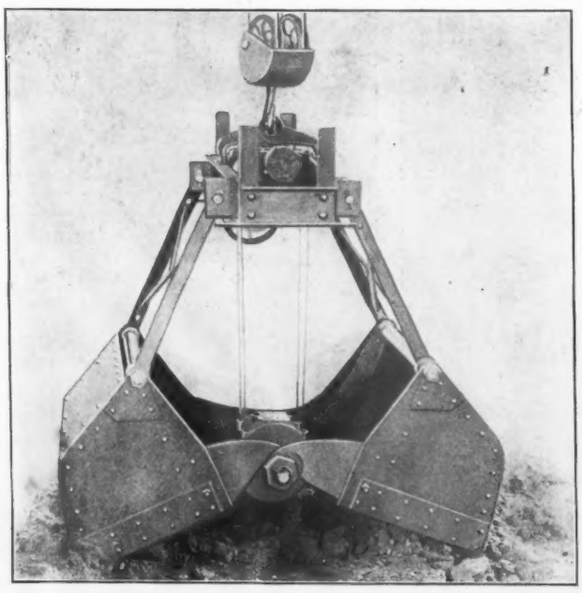


FIG. 1—SELF-CONTAINED CLAM-SHELL BUCKET IN OPEN POSITION

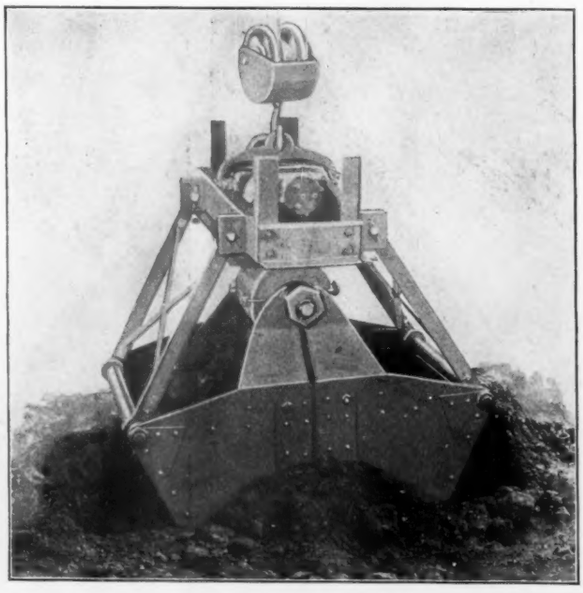
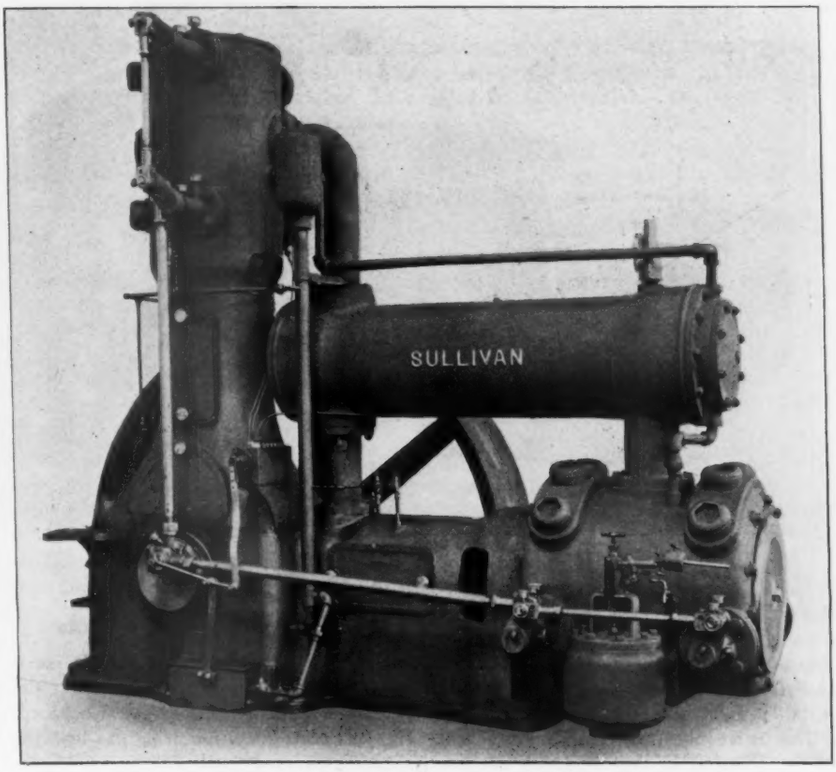


FIG. 2—SELF-CONTAINED CLAM-SHELL BUCKET CLOSED

Battery of Truck Core Ovens

A battery of truck core ovens recently has been installed in a Cleveland foundry by the Oven Equipment & Mfg. Co., New Haven, Conn. The ovens, as shown in the accompanying illustration, are 28 feet long, 12 feet deep and 6½ feet high above the tracks. The battery is divided into two compartments, divided by a wall. Each compartment has two double doors, which open the full width to admit a truck of cores. Each compartment is heated also by an enclosed-flame gas burner, located at the center and operated from the back of the oven. Air at one pound pressure is forced through the burner by a positive pressure blower. The superheated air under pressure insures a circulation throughout the entire interior of the oven and forces the steam and gases through the vents shown at the right of the illustration. The oven is insulated on the sides, top and bottom, thereby preventing the radiation of the heat. The gas is burned in a steel pipe, entirely eliminating an open flame and an automatic valve is provided which shuts off the gas whenever the air pressure falls below a predetermined point. By this arrangement it is impossible for gas to accumulate in the oven and cause an explosion as a result of the sudden failure of the air pressure. The doors are so adjusted that they cannot be closed unless the vent dampers are open. This prevents putting a pressure on the oven without an adequate outlet for the gases.

A method of recovering zinc and copper from brass waste is the subject of a patent granted to Harvey M. Burkey, Newark, N. J. The brass turnings are mixed with finely-divided fuel, such as anthracite coal, and are subjected to an oxidizing blast in a converter of the Huntington-Heberlein type. The temperature and volume of air are so regulated that the zinc is oxidized, volatalized and collected in a suitable system of bags.

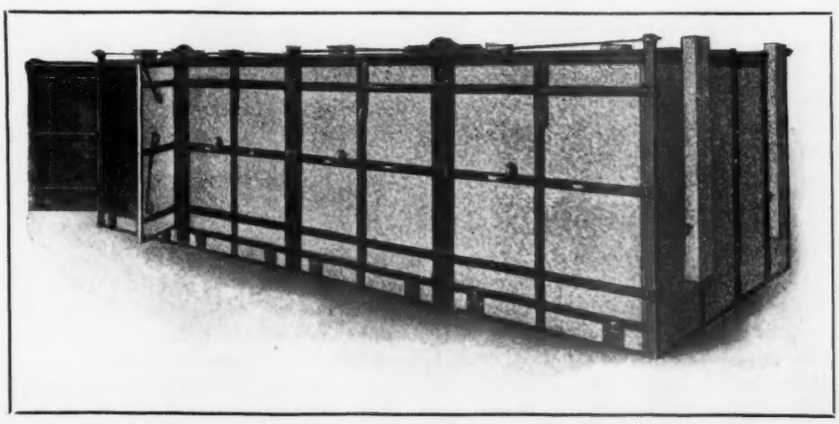


SULLIVAN ANGLE COMPOUND, BELT-DRIVEN AIR COMPRESSOR

Belt-Driven Air Compressor

With the increasing use of molding machines, hoists over floors, chipping hammers, rammers and other pneumatic equipment, in foundries, the need of air compressors in this industry has grown rapidly in recent years. A new type of compressor, particularly adapted for foundry service, designed by the Sullican Machinery Co., Chicago, is shown in the accompanying illustration. It is an angle compound, belt-driven machine, equipped with one high pressure and one low pressure cylinder, the latter being located in a horizontal and the former in a vertical plane. Both the low and high pressure pistons are driven by a single crank pin and all moving parts, except the valve gear, are provided with positive automatic lubrication enclosed entirely within the frames. The high pressure cylinder is supported in a vertical position above the crankshaft by a heavy frame or pedestal, having a broad base resting on the low pressure frame, to which it is secured by heavy bolts. The connecting rods are forged from open-hearth steel with marine type boxes on crank pin ends lined with babbitt metal. The cross-heads are forged solid and are slotted for the reception of bronze boxes provided with wedge screw adjustment. The crankshaft is an open-hearth steel forging of the center crank type. Heavy cast iron counterweights are attached to each crank cheek so proportioned that they equal in balancing effect the entire weight of the reciprocating parts of either the high or low pressure side.

On machines of 12-inch stroke or over, the end of the crankshaft outside the flywheel is supported in an out-board bearing. On machines of less than 12-inch stroke, no out-board bearing is supplied. Both the low and high pressure cylinders have separate liners forced in the main castings, the spacings between the liners and cylinder castings forming the water jackets. The air cylinder heads are bored transversely for cylindrical rolling inlet valves and are provided with ample ports for the admission of air. The air inlet valves are of the Corliss type and the inlet ports are of ample area to fill the cylinder at atmospheric pressure when the compressor operates at maximum speed. The air inlet valves are driven by steel valve



BATTERY OF TRUCK CORE OVENS BUILT BY THE OVEN EQUIPMENT & MFG. CO.

PRESSED STEEL POTS FOR MELTING LEAD, TIN, ZINC AND ALUMINUM

stems having T-heads on their inner ends. The air discharge valves are of the poppet type, internally guided on cast iron plugs, and are held to their seats by light steel springs.

The intercooler for removing the heat of compression in the air from the low pressure cylinder, consists of a cylindrical cast iron shell containing a nest of aluminum tubes through which the cooling water circulates, entering at one end, traversing one-half the tubes and returning through the remainder. The intercooler is located immediately over the low pressure cylinder and frame. The water circulation for the cylinders and intercooler have only one inlet and one outlet, entering at the bottom of the low pressure cylinder, then passing through the intercooler and high pressure cylinder, leaving the latter at the top. This arrangement provides a positive circulation with no danger of entrapping air in the water spaces. All cylinders are provided with tapped openings for the attachment of indicator connections. All air and water spaces in the cylinders and heads are provided with drain cocks which, when opened, will effectually drain every part so that there will be no danger of freezing when the machine is shut down in cold weather. The driving pulley is mounted at one side of the machine on an extension of the crankshaft. When desired, the compressor may be driven by an electric motor mounted directly on the crankshaft. In this case the regular belt pulley is replaced by a heavy, square-rimmed flywheel securely keyed to the shaft close to the compressor frame.

The H. W. Johns-Manville Co., New York City, recently received a contract for 200,000 square feet of built-up asbestos roofing, which will be used on the Michigan Central terminal, Detroit.

Pressed Steel Melting Pots

For melting non-ferrous metals, such as lead, tin, zinc and aluminum, the Eclipse Fuel Engineering Co., Rockford, Ill., is now manufacturing a line of seamless pressed steel pots, as shown in the accompanying illustration. The pots, being made of drawn steel, are of uniform thickness throughout and the section of steel entering into their construction is much lighter than is required in cast iron pots for similiar purposes. As a result, the capacity is slightly increased and it is claimed that the life of the pot is greater than that of a cast iron melting pot. The metals also are heated much more quickly than in a cast iron pot, owing to the comparatively thin section of the steel used in the construction of pots of the pressed steel type. Although the life of these pots is reduced somewhat by internal corrosion in the melting of zinc and aluminum, they give an average life great enough to recommend their use for these two metals. These pots are adapted to lead hardening, cyanide hardening, for holding caustic solutions, case hardening, etc. The pots are made in various diameters from 4 to 26 inches and can be furnished flanged with round bottoms, flanged with flat bottoms and without flanges having flat bottoms. These pots are particularly adapted for the use of gas as fuel.

Antimony and Bismuth

In a bulletin by Frank L. Hess, recently issued by the United States Geological Survey, are given the production of antimony and the importation of bismuth in 1912. The amount of antimony contained in antimonial lead of domestic origin last year was only 1,244 tons against 1,543 tons the previous year, while the imports of bismuth aggregated only 182,840 pounds. No antimony has been produced in the United States from domestic ore and no domestic antimony ores have been mined in the United States during 1912. Metallic bismuth is employed largely in making low fusing alloys or metals which are used in automatic fire sprinklers, fuses for electric wiring and solders. Selenium, one of the rarer metals, is reported as having been produced by one smelting company in 1912, and its value is estimated at $2.50 per pound.

McAdamite Metal

TO THE EDITOR:—

In the October issue of THE FOUNDRY, page 421, is published an answer to an inquiry for a McAdamite metal mixture, and I note with interest your quotations from the remarks made by me at a discussion upon aluminum at the Automobile Engineering Society, in this city. However, I must take exception to and issue with you on the voluntary information which you have given to the effect that "Aluminum, 82 pounds; copper, 3 pounds, and zinc, 15 pounds, cast in the usual manner (we presume you mean ordinary sand practice) will develop the same strength as the McAdamite metals, etc."? This is not a fact and the information is incorrect and misleading. Our alloys and methods of molding, etc., are protected against infringement by patents, but we offer for sale our pig or ingot metal to other aluminum foundries and we will furnish them with our special shop practice instructions which, if followed, will enable them to obtain superior results.

J. P. CARRITE, Treasurer,
United States McAdamite Metal Co.,
Detroit.

The Spotting-Out Problem and Silver-Plating

(*Continued from page* 503)

convert the entire mass into a liquid. This deliquescent property indicates that if there is an inclusion of cyanide it will attract moisture from the air, filling up the cavity and spreading over the surface.

Tests were made to determine the relative deliquescence of sodium and potassium cyanides. For this test the following samples were employed:

Sodium cyanide and potassium cyanide, indicated as chemically pure, and supplied as reagents for analytic laboratory work.

Sodium cyanide, commercial, having about 20 per cent chlorides as purchased on the market.

So-called sodium cyanide equivalent in strength to highest test potassium cyanide and containing about 80 per cent of sodium cyanide and 20 per cent of sodium chloride, made up by the writers.

Tests Made

Two grams of each of these materials were placed on a watch glass and spread out so as to present approximately similar surfaces. At various periods up to 71 hours weight determinations were made, the results being given in Table 1. These results indicate that the samples of the c. p. and the commercial sodium cyanides were similar in their behavior. In 71 hours the c. p. cyanide had taken up 195 per cent of its weight of water, while the commercial had taken up 188. On the other hand, it is clearly indicated that the potassium cyanide takes up water only about one-half as rapidly as does the sodium salt. The mixed cyanide and chloride sample was not run at the same time as the others and perhaps the comparison is not entirely justified. If any conclusions may be drawn from the data here presented it would be that the mixed cyanide is approximately as deliquescent as is the higher strength sodium cyanide.

On the supposition that the materials as used in the plating bath, after evaporating in the air, may not behave the same as do the materials as purchased, the sodium and potassium cyanides were first dissolved in water and then evaporated to dryness to a constant weight at a temperature of 100 degrees Cent. These samples were then exposed to the atmosphere and the rate at which water was absorbed was noted. The results are given in Table II, which indicates that while during the first three hours there was not a distinct difference between the sodium and potassium cyanides, at the end of 19 hours sodium cyanide had taken about twice as much water as had the potassium cyanide. At the end of 67 hours there was not as great a difference, although the potassium was still materially below the sodium cyanide.

It appears that while potassium cyanide was formerly used almost universally by platers, sodium cyanide has been very generally substituted for it during recent years. This has been brought about largely through the lower cost and greater availability of this material. Sodium cyanide can be manufactured with a much greater percentage of the cyanide radical than is possible with the potassium. This is due to a difference of atomic weight of sodium and potassium. In other words, while platers formerly expressed the strength of pure potassium cyanide as 100 per cent, the corresponding pure sodium cyanide would have a strength expressed as 133 per cent. To bring the strength of sodium cyanide so that it is equal to that of pure potassium cyanide, the presence of additional ingredients is possible, and it appears that a very common grade of cyanide now supplied to electroplaters contains about 80 per cent of cyanide, and about 20 per cent of chlorides, probably in the form of sodium chloride or salt.

During the operation of the plating solution there is, especially in hot weather, a gradual decomposition of the free cyanide necessitating a continual addition of fresh cyanide to keep up the strength, and this results in a marked concentration of chlorides in the solution after it has been used for some time. If the grade of cyanide containing 20 per cent of chloride is employed there will be a gradual increasing proportion of the inert chlorides. While the writers have no definite knowledge as to whether the presence of these chlorides is advantageous or otherwise from the standpoint of the operation of the bath, it is possible that they may have an influence upon the spotting-out problem.

Plating Solutions Tested

Three plating solutions were tested by taking 10 c. c. from each and evaporating down to dryness at a temperature of 100 degrees Cent. The solutions Nos. 1 and 2 were made up from sodium cyanides containing 20 per cent chloride. No. 1 had been in use with regular additions of silver and cyanide for about 10 months, and No. 2 had been in use about three months. A corresponding potassium cyanide plating solution which had recently been made up constituted solution No. 3.

The evaporating to dryness, solution No. 1 gave a residue of 2.793 grams; No. 2 solution gave 2.447 grams, while No. 3 solution gave a residue of 0.917 grams. The total material therefore which remains from the old solution was approximately three times as great as that from the potassium silver cyanide bath.

These various dried residues were then exposed to the atmosphere for 92 hours, periodical weight measurements being made. The results of these tests are given in Table III.

In a period of 92 hours the salt from solution No. 1 had taken up 3.541 grams, No. 2, 4.328 grams, and No. 3, 0.703 grams. In other words, the sodium cyanide residues took up from five to six times the amount of moisture that was taken up by the double potassium salt. Expressed in percentage of salt taken up per gram of residue, it appears that the double sodium salt with its content of sodium chloride takes up fully twice as large a percentage of moisture from the atmosphere as does the potassium double salt.

It may be suggested that the results in Table III indicate what might be expected from inclusions obtained from these three solutions. A cavity will, for example, take up a certain volume of liquid. On subjecting the articles to a drying process the amount of residues is proportional to the figures given in the second column of Table III. The amount of moisture which these residues will absorb from the atmosphere is proportional to the figures given in the fourth column of this table. This would indicate, then, that solution No. 1 is five times and solution No. 2 six times as harmful as is solution No. 3.

Sodium and Potassium Cyanide

There is no doubt that the spotting-out problem is of sufficient importance to warrant even more careful investigation than has thus far been devoted to it and a part of this investigation should include a study of the relative influence of the sodium of potassium cyanides. We cannot base a definite conclusion upon the mere fact that pure sodium cyanide attracts moisture more readily than does the similar potassium salt.

It is well known that during the operation of a plating bath the cyanides are gradually converted to carbonates. These carbonates may steadily accumulate in the bath, unless removed by the use of barium cyanide as a precipitating agent. Sodium carbonate is less deliquescent than is the potassium carbonate and we thus have a factor which may argue for the superiority of the sodium cyanide.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The firm name of the Ronalds & Johnson Co., New York City, has been changed to the J. D. Johnson Co.

Fire at the plant of the Pueblo Foundry & Machine Co., Pueblo, Colo., partially destroyed the core box storage room, but only temporarily crippled the plant.

The Burr Co., Champaign, Ill., has moved into its new north works and is remodeling the city plant into a shop for repairing automobiles.

The Humphrey Pipe & Foundry Co., Bellefontaine, O., has purchased the plant of the Bellefontaine Foundry & Machine Co., that city, and will occupy the buildings in the spring.

The Bridgeport Foundry & Machine Co., Bridgeport, Pa., has been incorporated for $30,000 by B. F. Evans, J. C. Laird, Norristown, Pa.; J. J. Murphy, Bridgeport, and others.

A Tropenas converter has been installed in the Norfolk, Va., navy yard, the first heat having been made on Oct. 9. Heretofore no steel castings have been made in this foundry.

The warehouse and blacksmith shop of the McLennan Foundry & Machine Works, Ltd., Campbellton, N. B., Can., were destroyed by fire recently, entailing a loss of $10,000. New buildings have been erected and the machinery is being installed.

A new company has been organized, under the same name, to take over the plant of the London Foundry Co., London, Ont., and will manufacture hardware, etc. Directors of the new company are Ernest Grobbe, St. Catherines, president; W. P. Kearney, Montreal; Fred McLean, St. Catherines; David J. Cowan and Joshua Garrett, London.

New Construction

The Batavia Foundry Co., Batavia, O., will erect an addition, 36 x 48 feet.

The American Range & Foundry Co., Cleveland, will erect a 48 x 95-foot addition.

The Ohio Foundry Co., Cleveland, will erect an addition to its plant to be used for an assembling building.

The Dow Wire & Iron Works, Louisville, Ky., is constructing an addition to its foundry, 77 x 85 feet.

The F. S. Lang Mfg. Co., 2756 First avenue South, Seattle, Wash., will erect a 100 x 50-foot frame foundry.

The Imperial Foundry Co., Ltd., Milton, Ont., Can., is erecting a building, 65 x 260 feet, which, with the extra equipment, will cost about $40,000. The company has a five-acre site on the Canadian Pacific railroad.

The Dominion Steel Foundry Co., Ltd., Hamilton, Ont., is enlarging its annealing, finishing and shipping departments. The equipment, including a 500-ton straightening press, sprue cutters, saws, etc., has been purchased.

The Canada Stove & Furniture Co., Ltd., Montreal, Can., is building a stove foundry, which will be in operation about the first of the year. The James Shearer Co., 225 St. Patrick street, that city, is the general contractor.

Directors of the Waynesboro Metal & Foundry Co., Waynesboro, Pa., plan to double the output. Charles M. Tritsch, Hagerstown, Md., has bought the interest of Frederick D. Miller and has succeeded him as president and general manager. Mr. Tritsch was for 16 years general foreman, master mechanic and superintendent of motive power of the Western Maryland railroad.

The Pittsburgh Iron & Steel Foundries Co., Midland, Pa., is contracting for two new electric traveling cranes of large capacity, a new heating furnace and other equipment, which will give it a capacity equal to the largest foundries in the Pittsburgh district. The improvements are made to take care of the increased demand for Adamite rolls and castings. The company plans to increase its operating force.

The Malleable Iron Range Co., Beaver Dam, Wis., will double its capacity by the erection of a two-story brick structure, 65 x 74 feet; a wing, 35 x 60 feet, to the warehouse and a new shipping room. Next year the company plans to install muffle furnaces for processing polished castings, additional foundry accommodations and a large building for general purposes. The extensions will cost $85,000. The company at present employs 500 men.

The Seattle Brass Co., Seattle, Wash., recently added two oil-burning crucible furnaces to its foundry and shortly will install additional furnaces to increase the melting capacity to 5,000 pounds per heat to handle the large propeller business on the Pacific coast. The company recently furnished the Heffernan Engine Works four propeller blades weighing 14,000 pounds for the steamer Mariposa. The blades were cast in Ajax manganese bronze, the company having the northwest agency of the Ajax Metal Co., Philadelphia.

NEW TRADE PUBLICATIONS

CHAPLETS AND ANCHORS.—In a 14-page booklet, issued by the Philadelphia Chaplet & Mfg. Co., Philadelphia, the complete line of chaplets, anchors, etc., manufactured by this company is illustrated and described and prices are included covering all of these products.

EYE PROTECTORS.—A 28-page booklet published by T. A. Willson & Co., Inc., Reading, Pa., is devoted to eye protectors for industrial use. The safety glasses manufactured by this company are illustrated and described in detail and numerous suggestions are made covering the protection of eyes of workmen in industrial service.

CORE OVENS.—In a four-page circular, issued by the Quigley Furnace & Foundry Co., Springfield, Mass., the continuous revolving shelf or reel type core oven is illustrated and described. This oven is adapted for the use of coal, coke, oil or gas as fuel. The oven is of the sectional type and any number of units can be installed to meet the requirements of a foundry.

PNEUMATIC HAMMERS AND RIVETERS.—An eight-page bulletin, issued by the Ingersoll-Rand Co., New York City, is devoted to a new line of riveting hammers suitable for structural, tank or any other similar work requiring rivets up to 1¼ inches in diameter. A well-illustrated booklet, also issued by this company, is devoted to a core drill suitable for coring in mining operations, prospecting, etc.

FOUNDRY EQUIPMENT.—Two bulletins, issued by the Whiting Foundry Equipment Co., Harvey, Ill., are devoted to the Watters' quick-detachable grab bucket and the Whiting converter. The grab bucket is particularly adapted for foundry use and can be employed for cleaning up floors, conveying sand from one part of the shop to another and also for handling coal, ashes and other similar material. The bulletin describing the Whiting converter contains illustrations of numerous installations in various shops, as well as details of the construction and operation of this melting medium.

HOISTS. — In a 16-page bulletin recently issued by the Pawling & Harnischfeger Co., Milwaukee, a new motor-driven hoist for I-beam operation is illustrated and described. This hoist also is made in different types for hook suspension, with truck operated by a hand chain wheel, with motor-driven truck and floor-operated controllers and with motor-driven truck controlled from a traveling, open or enclosed type cage.

EXHAUST FAN OUTFITS. — A 12-page bulletin, issued by the Sprague Electric Wks., of the General Electric Co., New York City, is devoted to motor-driven exhaust fan outfits both direct and alternating current. All outfits are furnished totally enclosed and the round type, direct-current motors have hinged doors which may be readily opened for inspection or cleaning of the commutator and brush rigging. Standard alternating current outfits are provided with constant speed motors of the squirrel cage type. The motor, fan and tripod make up a unit combination and can readily be installed on any proper vertical support.

IRRIGATION. — A handsomely illustrated 78-page booklet entitled "Irrigation" has been issued by the Henry R. Worthington Hydraulic Works, 115 Broadway, New York City. The conservation and distribution of water for irrigation, with particular reference to the machinery used for this purpose built by Henry R. Worthington, is discussed at length and many interesting illustrations are included showing various irrigation products and the pumping plants installed for irrigation work. Numerous tables also are included which should prove of value to engineers.